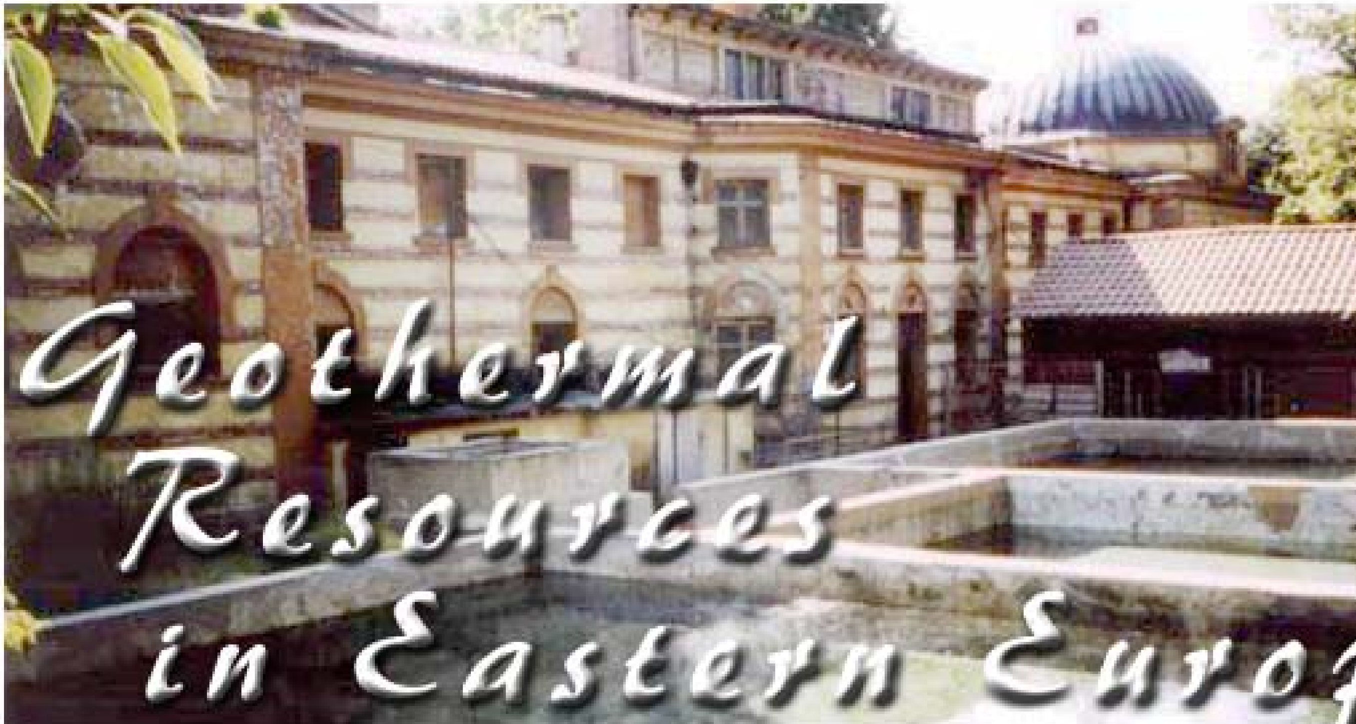
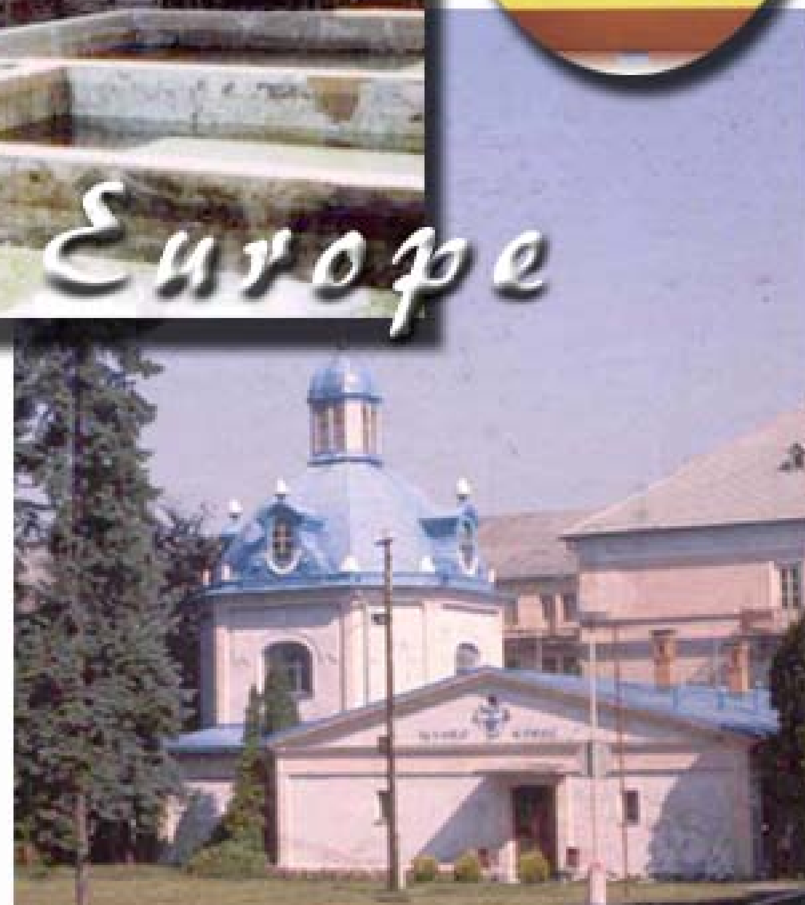
Geothermal Resources in Eastern Europe





By Liz Battocletti, Bob Lawrence & Associates, Inc.

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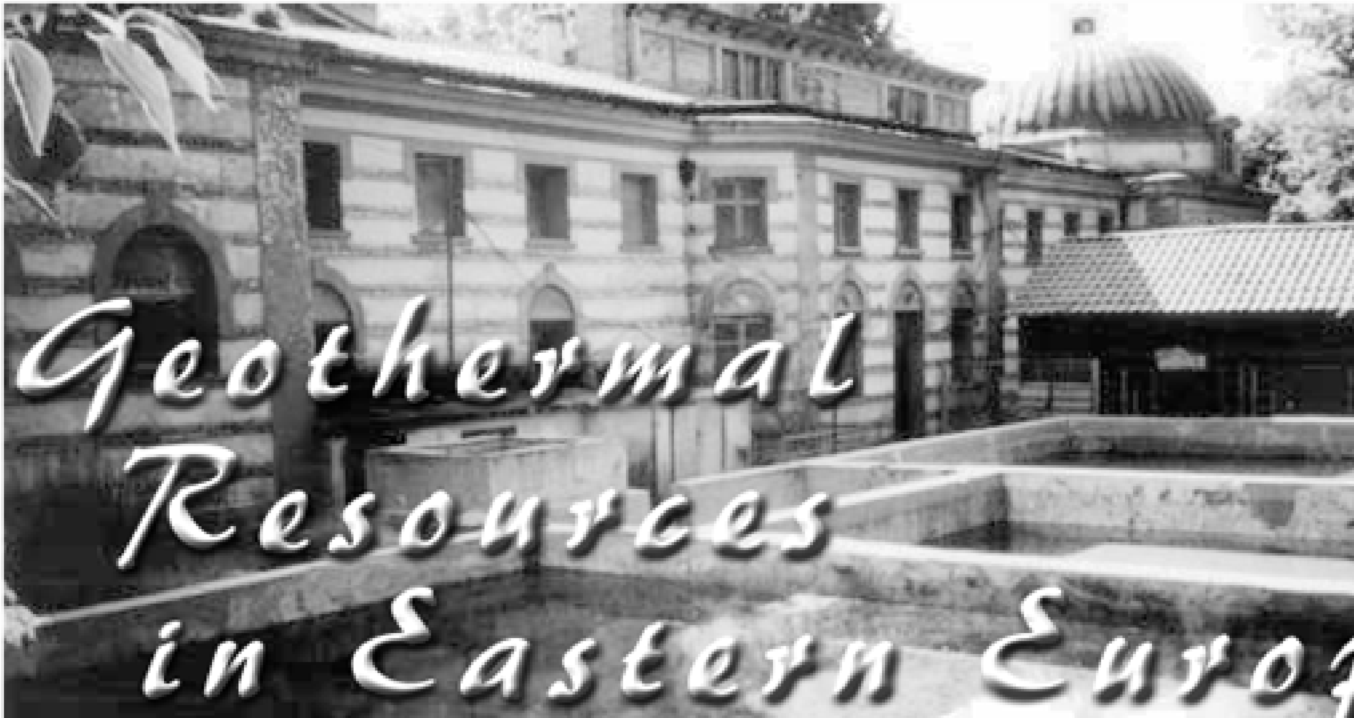

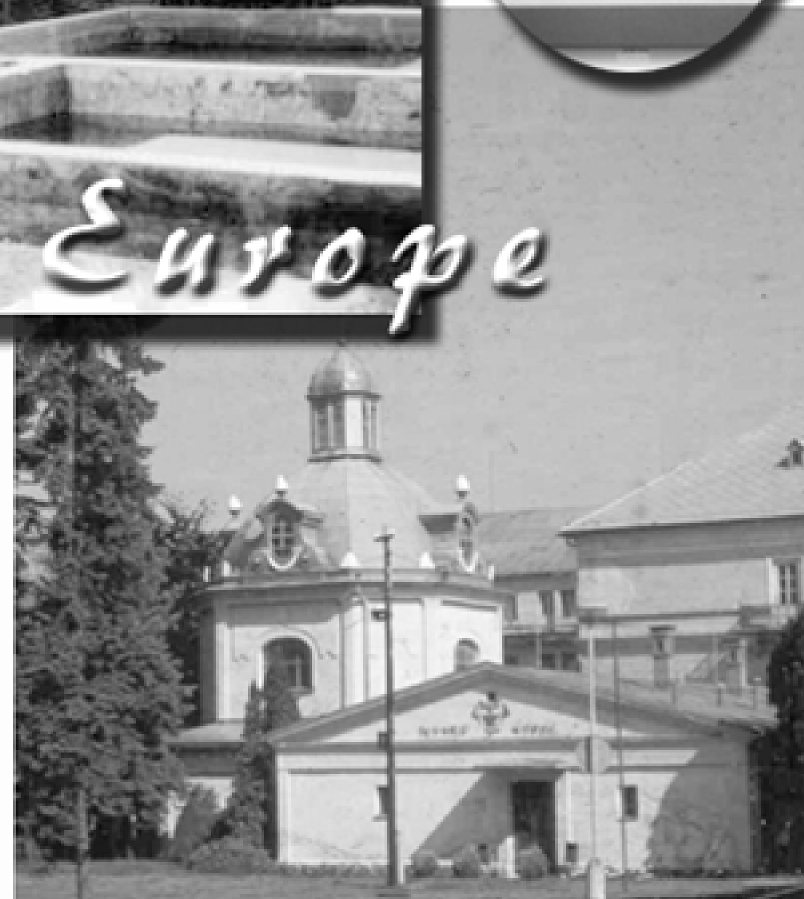

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By Liz Battocletti, Bob Lawrence & Associates, Inc.

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Table of Contents

Introduction

The **Database of Geothermal Resources in Eastern Europe** contains information on 366 specific geothermal sites or projects in five countries: Bulgaria, the Czech Republic, Romania, Slovakia, and Ukraine.

A summary of geothermal resources found in the five countries is shown in Table 1. The 366 sites have a total projected electricity generation potential of 1,430 MWe and a total direct use potential of 28,118 MWt. Twenty-seven or 7.4% of the sites have a temperature of 100ºC or more, and may be suitable for power generation development.

The Database and market research report were designed, built, and written by a team led by Liz Battocletti of Bob Lawrence & Associates, Inc. (BL&A) for UT-Battelle LLC under Purchase Order Number F99-181039, "Collection and Assembly of Published Data on Geothermal Potential." It was compiled using information collected in an extensive data and Internet search which accessed technical literature dating back over 25 years, as well as numerous U.S. and regional sources.

Special appreciation is due Joel Renner of Idaho National Engineering and Environmental Laboratory (INEEL) and Allan Jelacic of the U.S. Department of Energy's Office of Wind and Geothermal Technologies for their support.

Particular thanks goes to Antonin Beran, Energy Statistics Unit, Ministry of Industry and Trade of the Czech Republic; Klara Bojadgieva, Department of Geophysics, Oil and Gas Exploration and Production (Bulgaria); Marnell Dickson, International Institute for Geothermal Research, Area della Ricerca CNR; Albena Gerova, Commercial Counselor, Bulgarian Embassy; John Lund and Toni Boyd, Geo-Heat Center, Oregon Institute of Technology; Ladislaus Rybach, Institute of Geophysics; Carsten Schwensen, Kvistgaard Consult ApS; Victoria Sergeeva, Commercial Specialist, U.S. Embassy–Ukraine; Vesela Sotirova, Chief Legal Expert, Bulgarian Foreign Investment Agency; Marian Volent, Commercial Specialist, U.S. Embassy–Slovak Republic; Georgy Zabarny, Ukrainian National Academy of Sciences; and the other individuals, companies, and organizations who provided assistance and information.

Cover photos were generously provided by Klara Bojadgieva and John Lund. Clockwise from the upper left corner they are: Kjustendil, Bulgaria, a thermal bath built in 1912; a balneotherapy center at the Albena resort, Bulgaria; and two photographs of the Piestany spa in Slovakia.

For immediate dissemination to the industry, the report has been converted to a PDF file.[1]

The **Database of Geothermal Resources in Eastern Europe** includes:

- Power Profile - basic information on population, GDP, installed capacity, electricity prices, etc.;
- Power Summary - description of the power sector and privatization efforts;
- Government / Legislation - relevant government agencies and laws; and
- Geothermal Sites / Projects - a Site Summary for each:

    1. Name
    2. Location
    3. Status
    4. Temperature
    5. Installed Capacity (MWe/MWt)
    6. Potential (MWe/MWt)
    7. Chronology
    8. Notes

[1] PDF files can be read and printed using the free Adobe® Acrobat® Reader which can be downloaded at http://www.adobe.com/products/acrobat/readstep.html.

Dynamic Database

The Database is designed to be dynamic. Created using Microsoft® Access 2000, it can be easily updated or modified to include specific data which the industry would find most useful. In addition, the Database can be made more comprehensive by adding pertinent data, e.g., local population and market data, location of transmission lines and roads, etc., using the Geographic Information System (GIS), to the present structure.

To date, BL&A has conducted similar extensive surveys of geothermal resources in Latin America and the Caribbean, Turkey, Poland, China, Hungary, Russia, and the Balkans, building Microsoft® Access 2000 databases for each. The databases could be adapted for posting on the World Wide Web and searched using a variety of variables, e.g., country, temperature of resource, estimated power potential, and other parameters.

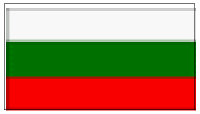
Country	Number of Geothermal Sites /	Maximum Temp. (ºC)	Average Temp. (ºC)	Number of Sites >100ºC	Power Generation Potential	Direct Use Potential (MWt)
Bulgaria	192	150	38.9	7	200	1,800
Czech Republic	19	72	13.2	0	Unknown	3,300
Romania	72	300	53.5	5	200	480
Slovakia	55	165	37.4	2	30	5,538
Ukraine	28	210	59.8	13	1,000	17,000
TOTALS	**366**			**27**	**1,430**	**28,118**

Table 1 – Geothermal Resources in Eastern Europe

Map No.3976 Rev. 1 UNITED NATIONS
September 1998

Department of Public Information
Cartographic Section

Eastern Europe



Bulgaria

Power Profile

Population (millions) -July 2000 estimated	7.71
GDP (billion US$) - 2000 estimated	48.0
Real GDP Growth Rate - 2001 estimated	4.2%
Inflation Rate (CPI) - 2000	11.4%
Total Installed Capacity (MWe) - January 2001	13,189
Electricity Consumption per Capita (kWh) - 2000	3,633
Energy Demand Growth Rate	1.8%
Prices (US¢/kWh) – countrywide averages, 2000	
Residential	3.4
Industrial	3.9
Source: EBRD, *Transition report 2001*	
Geothermal Power Potential (MWe)	200
Geothermal Direct Use Potential (MWt)	1,800

Slightly larger than Tennessee, Bulgaria shares borders with Greece, the Former Yugoslav Republic of Macedonia (FYR Macedonia), Romania, Serbia and Montenegro, Turkey, and the Black Sea.

Bulgaria fell within the Soviet sphere of influence and became a People's Republic following World War II. Communist domination ended in 1991. In the decade since, Bulgaria has made considerable progress in moving from a command and control economy to democracy and a market-based system.

In 1997, Bulgaria achieved a major turnaround of its economy by adopting a currency board system. The Bulgarian lev was pegged at first to the German mark and then to the Euro. This led to a sharp drop in inflation and growth in GDP. Bulgaria's GDP is projected to grow by 4-5% this year.

Following parliamentary elections in June, former-king-turned-prime-minister Simeon II (Simeon Saxe-Coburg) created a young, reform-minded government led by two Western-trained bankers: 31-year old Deputy Prime Minister Nikolai Vassilev and 35-year old Minister of Finance Milen Veltchev. The new government's economic program includes tax cuts to attract investment, an increase in minimum wages in the public sector, and low interest loans to increase small private businesses.

The Bulgarian Government and the International Monetary Fund (IMF) are negotiating an agreement on the 2002 budget. A signed agreement is expected by the end of this year. The IMF's main priority is the country's energy and transport policies.

In November, Georgi Parvanov of the Bulgarian Socialist Party was elected president.

Bulgaria is pursuing accession to the European Union (EU), and hopes to become a member between 2004 and 2007. The country is working towards full NATO membership and has been active in NATO's Partnership for Peace program since 1994. Bulgaria became a full member of the World Trade Organization in 1996.

Power Summary

Bulgaria has a total installed capacity of 13,189 MWe: 49.4% in thermal power plants, 28.9% in nuclear power plants, and 21.7% is hydropower plants. An additional 2,800 MW will be constructed by 2020.

The forecast for electricity consumption in Bulgaria is 52 TWh in 2010 and about 57.5 TWh in 2020.

Bulgaria's main hydrocarbon reserves consist of mainly low quality lignite coal produced in open cast mines. Coal will remain an indispensable energy source for the foreseeable future with the cheapest fuel for power plants coming from Maritza East, Bulgaria's most economic deposit and amongst the largest coal mines in the world.

Almost 50% of the country's power is generated by the Kozloduy Nuclear Power Plant (NPP) on the Danube River. Bulgaria will close two of the four units of the plant in 2002-2003. The two remaining newer units will be modernized by Westinghouse Electric Company. Bulgaria is negotiating with the EU on their closure.

In addition to Westinghouse, other U.S. companies are making major investments in Bulgaria's energy sector. AES is investing $750 million to build a new power plant, and Entergy is investing $250 million to enlarge and modernize an existing power plant.

A study financed by Phare concluded that renewables could account from 1.9-7.6% of Bulgaria's total energy. Economic efficiency of renewable energy in Bulgaria will be reached when the average price of electricity becomes 8¢/ kWh, not factoring in the "ecological" value of renewables.

Bulgaria is an energy importer, depending on imports for 70% of its energy supplies. Industrial restructuring and a decline in industrial production, however, have lowered domestic demand for energy and allowed the country to export electricity. Bulgaria exports electricity to Albania, FYR Macedonia, Greece, Turkey, and Yugoslavia, generating US$ 150 million in 2000. The country is well-situated to become a regional energy hub.

Over the next few years, Bulgaria will need to make several major investment decisions in the energy sector, including rehabilitation, retirement or replacement of old, inefficient or unsafe power plants; expansion of electricity and gas transmission networks to boost exports; and development of a domestic low-pressure gas market. These investment decisions will also need to take into account EU accession requirements, e.g., particulate and sulfur emissions, nuclear safety and the closure of the older nuclear plants, and energy security (*World Bank Energy and Environment Strategy Study*, 2001).

Government / Legislation

<u>Ministry of Energy and Energy Resources (MEER)</u>

MEER manages and controls the enterprises for production, processing, transportation and sales of fuels and energy. Prior to June 1996, the energy sector was managed by the Governmental Committee of Energy. In June 1996 the Committee of Energy became the Ministry of Energy and Energy Resources.

<u>Council of Ministers</u>

The Council of Ministers directly governs the State Energy and Energy Resources Agency (SEETA), the State Energy Regulatory Commission (SERC), and the State Energy Efficiency Agency (SEEA). Effective 14 November, all agencies will report to the Ministry of Energy which in turn reports to the Council of Ministers.

The Council of Ministers defines the mandatory rules of setting and enforcing the prices and tariffs of electric and heat energy and natural gas at SERC's proposal. According to law, "The regulation of the prices in the energy sector shall be carried out on the basis of objective and non-discriminatory criteria, ensuring a balance among the economic interests of energy enterprises and customers."

Effective 1 January 2002, electricity prices will be determined by SERC and not by the Cabinet as it is now.

<u>State Energy and Energy Resources Agency (SEERA or SAPEER)</u>

SEERA develops and implements Bulgaria's energy policy. The Bulgarian government's latest energy strategy was outlined in the 1998 document, "National Strategy for Development of Energy and Energy Efficiency Till 2010" which was approved by the National Assembly in 2001. SEERA was transformed into the Ministry of Energy and Energy Resources in November.

National Strategy for the Development of the Energy Sector until 2010

The "National Strategy for the Development of the Energy Sector until 2010" describes the country's energy development strategy and investment priorities. The national strategy calls for the restructuring of the Bulgarian state-owned electricity company, Nationalna Elektricheska Kompania (NEK).

State Energy Regulatory Commission (SERC)

Created by the Energy and Energy Efficiency Act of July 1999, SERC issues permits and licenses; controls and approves prices; and controls contracts between generation, transmission, and distribution companies.

State Energy Efficiency Agency (SEEA)

Re-established in 1997, SEEA defines state policy on energy saving and the development of renewable energy sources, including geothermal energy. The agency has developed a draft of a national renewable energy sources program, which includes more than 780 investment projects. Of the total, there are 38 geothermal projects at a total cost of US$ 384 million–4 projects have been approved by the ministries; 34 projects have been approved by regional governments.

National Electric Company (Nationalna Elektricheska Kompania [NEK])

NEK is currently Bulgaria's only buyer of electricity from distributors and the only electricity exporter. The state monopoly owns the transmission company and large hydropower plants, and acts as system operator.

NEK's restructuring began in 2000 when seven distribution and seven generation companies were detached as independent legal entities and registered in conformity with the Commerce Act, and according to the Single Buyer model, which meets the requirements of the European Commission (EC) Directive 96/92 for the general rules of the domestic market for electrical power.

Following restructuring, NEK will own the transmission system and act as an independent system operator (ISO) of the national grid through the National Dispatching Center. NEK will be the ISO and only buyer and seller of electricity until 1 January 2002 when third party access rules will come into effect.

Law for Power Engineering and Energy Efficiency ("Energy and Energy Efficiency Act")

The Energy and Energy Efficiency Act created the basic regulatory and legislative framework for the market-oriented development of the country's power sector. The Act provides conditions for:

- Developing a modern competitive energy market:
- Attracting investments in and privatization of the sphere of power engineering:
- Providing energy supplies at minimal expenses:
- Increasing energy efficiency:
- Encouraging the use of renewable energy resources: and
- Integrating the Bulgarian energy system and energy market with the European ones.

The Act also anticipates the opening of a domestic power market as defined by EU electricity directive 96/92, allowing for a single buyer with regulated access to the grid for eligible customers from early 2002. Third party access rules will come into effect beginning 1 January 2002. Terms and conditions will be determined by an Ordinance of the Council of Ministers. Bulgaria hopes that at least 30% of the power market will be opened by 2003.

On 14 November 2001, the Parliament approved changes to the Act. Under the amendments, SEERA will become the Ministry of Energy and Energy Resources, rather than a separate agency. In addition, SEEA will come under the direct purview of the Ministry rather than the entire Cabinet of Ministers.

Bulgaria will liberalize its energy market beginning in 2002 to make it more competitive and to meet EU accession criteria.

Tariffs

The new government planned to increase electricity and heating tariffs for households effective 1 October, citing the need to close the gap between revenues and costs for utility companies, and to adjust the differential between charges to individual and industrial consumers (PlanEcon, 2001).

The Court abolished the decision of the Council of Ministers' move to increase tariffs after the unions (syndicates) challenged the decision, contending that they were not consulted in the process. The Court sustained their challenge. An increase in electricity tariffs has been postponed until early 2002.

A drastic appreciation of electricity is expected in 2003-2004. By 2006, prices must rise to a level close to the European average of 5-8¢/kWh. Currently, a kWh in Bulgaria is sold at about 4¢/kWh.

Foreign Investment

The investment climate in Bulgaria is rapidly improving and U.S. companies are now seeing the advantages of doing business in the country. Bulgaria offers a highly educated work force and low labor costs. One of the industry sectors with the best prospects for U.S. firms is electrical power generation equipment (*Country Commercial Guide*, 2001).

Foreign direct investment (FDI) in Bulgaria was comparatively low until 1997, but has since increased, totaling US$ 1.1 billion in 2000. Bulgaria projects FDI inflows in 2001 will reach US$ 1.3 billion. The economy has the capacity to absorb as much as US$ 2 billion in FDI annually. The United States is the sixth largest investor in Bulgaria, after Germany, Greece, Italy, Belgium, and Austria. U.S. companies invested US$ 269 million investment in Bulgaria in the first six months of 2001.

The Bulgarian government has a very liberal and open attitude towards foreign investors. In recent years, a regulatory environment that provides very favorable conditions for foreign investors has been put in place and harmonization of the legal framework with EU requirements has also begun.

Prime Minister Saxe-Coburg announced that his government will adopt new measures to encourage foreign investment in Bulgaria. New legislation encouraging foreign investment will be introduced to the parliament and the cabinet is examining a new privatization law that provides both speed and transparency. Saxe-Coburg also stated that international accounting standards will be introduced in Bulgaria and the number of licenses required for starting a company will be dramatically decreased.

Law on Foreign Investment (1997)

The 1997 Law on Foreign Investment established the Bulgarian Foreign Investment Agency as the government's coordinating body for foreign investment. The law extends national treatment to foreign investors, guarantees compensation in the event of expropriation, and allows the repatriation of profits. The law explicitly recognizes intellectual property and securities treasury bonds as a foreign investment. The law does not limit the extent or amount of foreign participation in companies. Foreign companies have the right to open deposit accounts in hard currency and Bulgarian lev.

Foreign individuals cannot own land in Bulgaria. This is a constitutional prohibition which will eventually be changed to comply with European Union accession requirements.

Bulgarian Foreign Investment Agency (BFIA)

BFIA helps companies in the investment process. It provides up-to-date information to prospective investors on the investment process in the country, legal advice, identification of suitable Bulgarian partners, coordination of investment policy with other institutions, etc.

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No Specific Law for Geothermal

Bulgaria has no specific geothermal legislation. Regulations exist however, for obtaining leases, permits, and concessions, and there are guidelines in place for geothermal exploration permits and licensing geothermal exploitation. Geothermal licensing is issued by the state.

The Government of Bulgaria supports investment in geothermal projects through reduction of customs duties, and free utilization of existing wells. The government also offers VAT reduced by 2%, profit tax reduced by 3%, and expected reduction of taxes.

Under Bulgarian law, geothermal waters as a product of the bowels of the Earth are under the jurisdiction of the Constitution and the Waters Law. The use of geothermal waters for energy purposes is governed by the following laws:

- Law on Waters,
- Law on Concessions,
- Energy and Energy Efficiency Act, and
- Territorial Structure Law.

Law on Waters

Chapter 3, Article 47 states that the sole right for the use of waters is owned fully by the State and may be delivered via concession only for mineral waters when the use is for commercial purpose and is destined for the generation of hydrogeothermal energy. The law will be amended to comply with EU directives.

Law on Concessions (1995, amended 1997)

The law regulates the conditions and order for delivery of concessions. Chapter 1, Article 4 states that concessions may be delivered for the use of waters, including mineral ones which are exceptional state property.

The objectives of the energy sector, subject to concessions under the conditions and order of the above law, are as follows:

- Subterranean minerals (Chap. 4(1) p.1),
- Waters with national importance (Chap.4(1) p.7),
- Power stations for public electricity usage with more than 50 MWe,
- Distributing cabling networks, the main pipelines and ducts and their respective junctions for transporting energy resources and products (Chap.4(1) p.8), and
- Nuclear installations (Chap.4(1) p.10).

Article 2(2) determines the order of granting concessions as follows:

1. A decision for granting concessions is adopted by the Council of Ministers,
2. A competition or bid is held to determine the concessionaire, and
3. A concession contract is signed.

Concessions are awarded on the basis of a tender and are issued for up to 35 years. The law guarantees the transparency of the bidding process. Concessions can be extended but shall not exceed 50 years, although the former concession holder can legally be preferred in issuing a new concession for the same project or activity.

The law was amended in July 1997 to permit BOT deals. The law does not specifically address exploitation of hydro-geological resources.

<u>Energy and Energy Efficiency Act</u>: Article 22, item 2 states that electricity produced by renewable energy sources or combined-heat power (CHP) plants may be purchased at a preferential price which is defined by regulation and accepted by the Council of Ministers

Article 41, items 1, 2, and 3 state that no license is required for generation of electric energy of power below 5 MWe, thermal energy production of power up to 1 MWt, and self-generation.

<u>Public Health Act</u>

The Public Health Act grants permission to state-owned thermal resorts and tourist establishments to use thermal waters for medical treatment, for recreation, for heating or other domestic purposes, with no or minimal cost. This permission is still enforced today and also applies to privatized establishments. The Ministry of the Environment and Waters manages mineral and thermal waters in Bulgaria.

Geothermal Sites / Projects

Located on the Balkan Peninsula in southeastern Europe, Bulgaria is divided into four major geographic regions:

1. In the north, the Danube Plateau rises from the shores of the Danube River to the foothills in the east.

2. The Balkan Mountains are highest in the western part of the country and diminish towards the Black Sea in the east.

3. The Maritza River valley south of the Balkan Mountains.

4. The Rhodope Mountains in the southern part of the country.

Geologically, Bulgaria is a complex geological mosaic of platforms and orogenic structures, cut with deep tectonic faults, lithofacial, and magmatic contrasts with different behavior in the contemporary geo-dynamic processing. The geostructural picture of the country includes:

- The Moesian Platform and Balkan Foreland contain large commercial geothermal resources;
- The Malm-Valanginian reservoir contains thermal waters with temperatures of 25-75ºC and covers an area of over 15,000 km^2;
- The Triassic (Anisian) has highly mineralized thermal waters (100-140g/kg), some brines with temperatures up to 100ºC, and is not attractive for commercial utilization for the moment;
- The Devonian (Givetian) reservoir also contains also highly mineralized thermal waters and brines with temperatures reaching 100ºC; and
- The Srednogorie Zone and the Rodopian Massif have waters with exclusively meteoric genesis, very low mineralization (usually below 1g/kg), nitrogen, and temperatures of 25-110ºC (Penev and Shterev, 2000).

Bulgaria is rich in low enthalpy geothermal waters. About 1,000 thermal aquifers and thermal springs have been discovered. Southern Bulgaria has many hot springs. In the north, however, thermal pressurized water was discovered only by deep wells.

Geothermal waters have been used since ancient times for many types of direct uses, e.g., healing, bathing, swimming pools, and hypocausts (a type of Roman floor heating system). Sofia was founded by Thracian tribes in the 3rd century BC, sited around mineral springs (Bojadgieva et al., 1999).

More recently, the first modern Bulgarian systems were built after 1980 to heat buildings, greenhouses, and swimming pools.

The basic characteristics of geothermal water in Bulgaria were reassessed and updated in 1994-1998 by extensive study carried out by the specialists from the Geological Institute of the Bulgarian Academy of Sciences. Funded by the Ministry of Environment and Waters, the assessment examined data from 160 fields, 103 which are protected by the State. The assessment found that:

- The water temperature of the discovered reservoirs ranges between 20ºC and 100 ºC.
- The total flow rate of sub-thermal and thermal waters run up to 4600 l/s (Petrov et al., 1998), of which 3000 l/s is the flow rate of the discovered thermal waters (T>20ºC). About 33% of the total discovered flow rate is of temperature between 20ºC and 30ºC, and 43% between 40ºC and 60º.

According to Petrov et al.,1998 about 2300 l/s of recoverable resources could be discovered by additional drilling.

- Established chemical water content (TDS) varies from 0.1g/l to 50g/l - 100g/l. The prevailing thermal waters in Southern Bulgaria region are of nitrogen gas composition and are less than 1 g/l TDS. The highest percentage of low alkaline waters pH (7.2 - 8.5) is about 55% of the total flow rate.

- The total geothermal potential is defined as the thermal energy contained in the discovered thermal waters and it amounts to 14,122 TJ/year or about 440 MWt (Phare Project, 1997). This is a simplification as estimates of theoretical geothermal energy can be highly technical and include all energy beneath the earth's surface (Bojadgieva et al., 2000).

Thermal water is primarily used for balneology (healing and recreation), space heating and air-conditioning, hot water supply, greenhouses and aquaculture, and swimming pools and bottling. There is also some processing of flax and hemp fibers. A small enterprise for extraction of iodine, bromine, boron, strontium, etc. from the thermal water is in operation near Varna.

Bulgaria has an installed capacity of 107.2 MWt producing 1,637 TJ/yr of energy. Total flow is 1,690 kg/s; utilization is 455 GWh/yr; the capacity factor is 48% (Lund and Freeston, 2000).

Bulgaria has 448 MWt in unexploited, proven resources, of which only 20% has been developed. The country has a total of 1,800 MWt in unexploited, probable, and possible resources.

Two of the most promising areas for future development are the Lom depression, in the western part of the Moesian platform, and the Rila-Rhodope region. In the former, down hole measurements have resulted in temperature values of 115-120ºC at depths of 3 km. In the latter, measurements at 3 km have shown temperatures of 70-80ºC.

Bulgaria has no electricity generated from geothermal resources. The country's estimated power generation potential is 200 MWe.[2]

Bulgaria's potential markets for geothermal are district heating, greenhouses and agriculture, health spas, combined space heating and cooling, and cascaded uses, and to a lesser extent–fish farming, swimming pools, and industrial processes. While no special financing programs exist for geothermal projects, geothermal investments can

[2] Geothermal Energy Association, *Preliminary Report: Geothermal Energy, the Potential for Clean Power from the Earth* (Washington, D.C., April 1999).

be supported by European programs, e.g., Phare, Interreg, and Energie.

From 1994-1996, the Phare Project studied the renewable energy potential of Bulgaria and completely financed two small demonstration projects (0.20-0.40 MWt). A larger system in Sapareva Banja is being considered.

The "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project was implemented within the framework of the European program Energie. The project aims to promote modern successful geothermal technologies in the Bulgarian and Northern Greece markets, and examined 25 geothermal installations in Bulgaria.

The **Database of Geothermal Resources in Eastern Europe** contains information on 192 specific geothermal sites or projects in Bulgaria. See Table 2 for a complete listing of the sites, their development status, temperature (ºC), and electric power generation potential. A complete description of each site, to the extent information is available, is included in the Appendix.

Bulgaria's highest enthalpy geothermal resource identified to date is Sapareva Banya with a temperature of 115ºC. Burgaski Bani may be a hotter resource with a maximum predicted temperature of 150ºC. The average temperature of all sites in the country is 38.9ºC. Seven sites have a temperature of 100ºC or more.

Site/Project Name	Status	Temperature (ºC)
Aitos	Feasibility study	19-52
Al. Voikov	Feasibility study	43-56
Albena	Well(s) or hole(s) drilled	28-30
Assenovgrad	Preliminary identification/report	26-36
Bachevo	Feasibility study	26-46
Badino	Preliminary identification/report	19-50
Balchik	Preliminary identification/report	24

Site/Project Name	Status	Temperature (ºC)
Banevo	Preliminary identification/report	24
Banya	Preliminary identification/report	28-58
Bankia	Direct use -- developed	28-42
Banya Karlovo	Direct use -- developed	35-54
Banya Panagiursko	Direct use -- developed	25-43
Banya-Korten	Direct use -- developed	42-86
Banya-Plovdiv	Direct use -- developed	46
Banya-Razlog	Direct use -- developed	—
Barzia	Direct use -- developed	31-66
Batchevo	Preliminary identification/report	21-26
Bedenski bani	Direct use -- developed	73-76
Belchin Banya	Direct use -- developed	41-42
Belovo	Feasibility study	20-25
Biala voda	Preliminary identification/report	27
Birimirtzi	Feasibility study	30-65
Blagoevgrad	Direct use -- developed	55-100
Boaza-Turgovishte	Preliminary identification/report	26
Bratzigovo	Direct use -- developed	18-26
Bresovo	Well(s) or hole(s) drilled	21
Burgaski Bani	Direct use -- developed	20-150

Site/Project Name	Status	Temperature (ºC)
Burzhia	Preliminary identification/report	33
Chaika	Direct use -- developed	25-45
Chepino	Direct use -- developed	32-48
Chepintci	Feasibility study	51-60
Chifflik	Direct use -- developed	39-51
Chuchuligovo	Preliminary identification/report	60
D. Bogrov	Well(s) or hole(s) drilled	28
D. Botevo	Prefeasibility study	21
Davidkovo	Prefeasibility study	35-44
Delchevo	Preliminary identification/report	35-80
Devin	Preliminary identification/report	44
Devnja	Well(s) or hole(s) drilled	19-21
Dobrinishte	Direct use -- developed	31-79
Dobroslabtzi	Preliminary identification/report	42
Dolna Banya	Direct use -- developed	55-65
Dolna Gradeshnitsa	Preliminary identification/report	60-80
Dolni Dubnik	Direct use -- developed	65-68
Dolni Lukovit	Preliminary identification/report	70-73
Dolni Rakovetz	Preliminary identification/report	21-36
Dolno Ossenovo	Preliminary identification/report	56-75

Site/Project Name	Status	Temperature (ºC)
Doupnitza	Preliminary identification/report	31-60
Draginovo	Direct use -- developed	59-97
Drouzhba ZK	Direct use -- developed	46-69
Dzhebel	Preliminary identification/report	33
Elenov dol	Preliminary identification/report	19-26
Eleshnitza	Direct use -- developed	21-56
Erma Reka	Feasibility study	87-100
Gnilane	Feasibility study	42-50
Gorna Banya	Direct use -- developed	16-42
Gorna Breznitza	Preliminary identification/report	38-55
Gorna Gradeshnitsa	Preliminary identification/report	67-80
Gotzedeltchevski Bani	Prefeasibility study	25-43
Gradeshka Banya	Prefeasibility study	45-68
Guliana Banya	Direct use -- developed	41-61
Gurmen-Ognianovo	Direct use -- developed	35-45
Harmanli	Prefeasibility study	13-23
Hisar	Direct use -- developed	23-69
Hotovo	Feasibility study	37-80
Hskovski bani	Direct use -- developed	40-60
Iakoruda	Direct use -- developed	43-77

Site/Project Name	Status	Temperature (ºC)
Illientzi	Feasibility study	52-58
Iskar	Reconnaissance	25
Ivaniane	Feasibility study	20-37
Jagoda	Direct use -- developed	28-61
Jeleznitsa	Feasibility study	21-32
Kableshkovo	Prefeasibility study	22
Kamenar TK-1	Preliminary identification/report	22
Kamenitsa	Direct use -- developed	53-91
Karnobat	Feasibility study	22-24
Katuntzi	Preliminary identification/report	38-75
Kavarna	Preliminary identification/report	30-32
Kazichane	Direct use -- developed	64-81
Kirkovo	Prefeasibility study	22
Kjustendil	Direct use -- developed	26-76
Kliment	Feasibility study	30-62
Klisura	Prefeasibility study	17-21
Kniazhevo	Direct use -- developed	23-40
Korten	Direct use -- developed	56-60
Kostadinovo	Direct use -- developed	35-50
Kostenetz	Direct use -- developed	36-88

Site/Project Name	Status	Temperature (ºC)
Kranevo	Well(s) or hole(s) drilled	24-30
Krasnovo	Feasibility study	21-56
Kraynitsi	Preliminary identification/report	21-60
Kresna	Preliminary identification/report	53
Krichim	Prefeasibility study	28-30
Kromodovo	Feasibility study	23-80
Krushuna	Preliminary identification/report	57-60
Kuklen	Preliminary identification/report	32
Kumaritza	Preliminary identification/report	36
Kurilo	Preliminary identification/report	26
Lenovo	Preliminary identification/report	48
Leshnitsa	Preliminary identification/report	35-80
Levunovo	Direct use -- developed	40-100
Lozenetz quarter	Preliminary identification/report	48
Ludzhene	Direct use -- developed	22-63
Luka	Preliminary identification/report	21
Marash	Direct use -- developed	40-67
Marikostinovo	Direct use -- developed	42-87
Medovo	Prefeasibility study	23-64
Merichleri	Direct use -- developed	21-60

Site/Project Name	Status	Temperature (ºC)
Mihalkovo	Feasibility study	13-98
Momin prohod	Direct use -- developed	41-88
Mramor	Feasibility study	42-91
Musomischta	Prefeasibility study	21-22
Narechenski bani	Direct use -- developed	21-109
Nevestino	Direct use -- developed	23-32
Novo Hodzhovo	Preliminary identification/report	70
Novo Konomladi	Preliminary identification/report	24-70
Obedinenie	Preliminary identification/report	48
Ognianovo	Direct use -- developed	—
Osenovo	Prefeasibility study	36-75
Oshtava	Prefeasibility study	40-75
Ovcha Kupel	Direct use -- developed	30-32
Ovcha moglia	Preliminary identification/report	45
Ovchartsi	Preliminary identification/report	70
Ovoshnik	Feasibility study	41-78
Palat	Preliminary identification/report	22-60
Panagurishte	Preliminary identification/report	48-57
Pancharevo	Direct use -- developed	43-48
Pavel Banya	Direct use -- developed	19-90

Site/Project Name	Status	Temperature (ºC)
Pchelni bani	Direct use -- developed	72-99
Pesnopoi	Feasibility study	30-76
Petrich	Preliminary identification/report	30-75
Pleven	Preliminary identification/report	64
Poibrene	Preliminary identification/report	38
Polianovo	Well(s) or hole(s) drilled	40-54
Polski Trumbesh	Preliminary identification/report	45
Posestia	Feasibility study	36
Rakitovo	Feasibility study	11-51
Ravno pole	Direct use -- developed	52-68
Ressen	Preliminary identification/report	55-56
Rila	Feasibility study	32-60
Roudartzi	Direct use -- developed	16-29
Roudnik	Preliminary identification/report	24
Rupite	Direct use -- developed	73-93
Rusalka	Preliminary identification/report	32
Sadievo	Preliminary identification/report	30
Sandanski	Direct use -- developed	17-108
Sapareva Banya	Direct use -- developed	33-115
Shabla	Preliminary identification/report	38-39

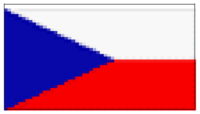
Site/Project Name	Status	Temperature (ºC)
Shipkovski Bani	Direct use -- developed	19-36
Simeonovgrad	Feasibility study	21-57
Simitli	Feasibility study	20-80
Slanchev briag	Direct use -- developed	31-37
Slatina	Prefeasibility study	18-50
Slavianovo	Preliminary identification/report	45
Slivenski Bani	Direct use -- developed	42-50
Sofia	Direct use -- developed	47-90
Somitlii	Direct use -- developed	62
Spanchevtzi	Prefeasibility study	14-50
Spatovo	Well(s) or hole(s) drilled	37-80
St. Karadzhovo	Direct use -- developed	15-22
Staro Jelezare	Feasibility study	20-29
Starozagorski Bani	Direct use -- developed	36-46
Stob	Preliminary identification/report	29-50
Stoletovo	Prefeasibility study	26-47
Straldja	Preliminary identification/report	77
Strelcha	Direct use -- developed	23-62
Struma	Prefeasibility study	57
Svetovrachene	Feasibility study	48

Site/Project Name	Status	Temperature (ºC)
Svishtoff	Preliminary identification/report	48-49
Svoboda quarter	Preliminary identification/report	50
Targovishte	Direct use -- developed	27
Topolitsa	Well(s) or hole(s) drilled	19
Topolovo	Preliminary identification/report	60
Touzlata	Preliminary identification/report	32
Trebich	Preliminary identification/report	51
Troyanovo	Preliminary identification/report	21
Varna City	Direct use -- developed	50-55
Varna-Droujba	Direct use -- developed	27-69
Varna-Evkisograd	Direct use -- developed	—
Varna-South	Direct use -- developed	51-55
Varshets	Direct use -- developed	20-49
Varvara	Direct use -- developed	14-91
Vidin	Preliminary identification/report	50
Vlahi	Preliminary identification/report	23-75
Vlahovo	Prefeasibility study	20-23
Voivodino	Preliminary identification/report	32
Vranya	Preliminary identification/report	22-75
Vurshech	Preliminary identification/report	37

Site/Project Name	Status	Temperature (ºC)
Yagoda	Preliminary identification/report	40-46
Yakoruda	Preliminary identification/report	42
Zeleni dol	Preliminary identification/report	61-75
Zlataritsa	Feasibility study	36-41
Zlatnia Pyasatzi	Direct use -- developed	21-38

Table 2 – Geothermal Resources in Bulgaria

Base 802232 (R01234) 6-94



Czech Republic

Power Profile

Population (millions) -July 2000 estimated	10.26
GDP (billion US$) - 2000 estimated	132.4
Real GDP Growth Rate - 2001 estimated	3.5%
Inflation Rate (CPI) - 2000 estimated	3.8%
Total Installed Capacity (MWe) - January 2000	15,073
Electricity Consumption per Capita (kWh) - 2000	5,483
Energy Demand Growth Rate	
Prices (US¢/kWh) – countrywide averages, 2000 Residential Industrial Source: EBRD, *Transition report 2001*	 4.5 4.3
Geothermal Power Potential (MWe)	0
Geothermal Direct Use Potential (MWt)	3,300

After World War II, Czechoslovakia fell within the Soviet sphere of influence. In 1968, an invasion by Warsaw Pact troops ended the efforts of the country's leaders to liberalize party rule and create "socialism with a human face." Anti-Soviet demonstrations the following year ushered in a period of harsh repression.

With the collapse of the USSR in 1989, Czechoslovakia regained its freedom through a peaceful "Velvet Revolution." On 1 January 1993, the country underwent a "velvet divorce" into its two national components: the Czech Republic and Slovakia.

The Czech Republic's transition to a free market-based economy has not been smooth. Political and financial crises in 1997 shattered the country's image as one of the most stable and prosperous of the post-Communist states. Delays in enterprise restructuring and failure to develop a well-functioning capital market played contributed to the country's economic troubles, culminating in a currency crisis. The 1998 recession resulted in a negative real GDP rate of -0.5% in 1999.

The country's economy began to grow again in 2000, driven by high FDI inflows and growing domestic demand (*EBRD Transition report*, 2001). The economic outlook for 2001 and 2002 is positive, with growth of 3.8% expected in 2001.

Threats exist, however, to the Czech Republic's continued strong economic growth in the medium-term. The most serious is the rapidly accelerating general government budget deficit which is 9.4% of GDP. Certain structural reforms, e.g., judicial reform, a new bankruptcy law, and privatization of remaining state-owned enterprises, also remain incomplete.

The Czech Republic is a member of several international and regional organizations including the Organization for Economic Cooperation and Development (OECD); the World Trade Organization; the Central European Free Trade Agreement (CEFTA), which also includes Slovakia, Hungary, Poland, and Slovenia; and NATO. The country hopes to join the EU by 2003.

The Czech Republic is slightly smaller than South Carolina. It shares borders with Austria, Germany, Poland, and Slovakia.

Power Summary

The Czech Republic has a total installed capacity of 15,073 MWe. The majority (74.3%) of generation capacity is owned by the country's former monopoly electricity producer; the balance is owned by independent producers, such as large industrial companies and heat producers. Electricity production by source is: 77.8% from fossil fuel, 3.43% from hydropower, and 18.77% from nuclear power.

Coal is the dominant fuel in the Czech Republic although its role is diminishing as that of natural gas and nuclear power increases. Oil and gas imports have been diversified and the Czech electricity grid has been connected to Western Europe.

The Czech Republic has two nuclear power plants–the 1,760-MWe Dukovany NPP, which provides 19% of the nation's electricity, and the 1,962-MWe Temelin NPP[3]. The first reactor at Temelin was commissioned in October 2000. When fully commissioned in 2002, Temelin NPP will provide 20% of the country's power needs. The country's electricity exports, which were 18.744 billion kWh in 2000, will continue to rise.

The Czech Republic has less than 20 MWe installed capacity in renewable sources (wind and photovoltaic). The goal is to increase the contribution of renewable sources of total consumption of primary energy sources from the current level of 1.5% to 3-6% by 2010 and 4-8% by 2020.

Along with electricity generation, electricity consumption is projected to steadily increase, much of it coming from increased demand from small-scale consumers, primarily

[3] Neighboring Austria has been opposing the Temelin NPP on safety grounds, despite the fact that the International Atomic Energy Agency has positively assessed the plant's safety standards and the Czech authorities have fully implemented all the agency's recommendations.

households. Further increases will be related to industry growth and price deregulation.

Government / Legislation

Working to harmonize Czech energy sector standards with those of the EU, the government has reformed its energy policies and regulatory framework and restructured its energy sector. Completion of energy sector reform is needed, however, to provide effective regulation in a liberalized sector and to facilitate privatization and the entry of new competitors (*EBRD Transition report,* 2001). The state still owns majority stakes in large energy companies, including the dominant power generating company.

Ministry of Industry and Trade (MIT)

The Ministry of Industry and Trade is responsible for the country's energy sector. It issues state approval to build new source facilities in the electricity, gas, and heat energy sectors; and ensures fulfilment of the obligations resulting from the international agreements and treaties binding on the Czech Republic or obligations resulting from membership in international organizations. In addition, MIT prepares the state's Energy Policy. With a horizon of 15 to 20 years, the draft document is presented to the government for approval. MIT also evaluates compliance to the policy.

New Energy Policy

On 13 January 2000, the Czech government approved a new energy policy based on that of the EU. The policy's key points are:

- Removal of subsidized energy prices for households by 2002,
- Privatization of distribution companies,
- New energy law approved by 2001,
- Independent regulatory agency established by 2001,
- Uranium ore mining shut down by 2001,
- Privatization of the monopoly CEZ in 2002,
- 6% energy market share of renewable sources by 2010,
- Brown coal mining completely shut down by 2030,
- Increasing importance of nuclear energy, and
- Construction of a third nuclear plant after 2015.

Ministry of Environment (ME)

The Ministry of Environment is responsible for preparing and evaluating compliance with the state's environmental policy.

Energy Regulatory Office (ERO)

Officially launched on 1 January 2001, ERO, under the purview of the Ministry of Industry and Trade, regulates and oversees the domestic energy market, and ensures that companies adhere to energy legislation. It grants licenses, sets rates that customers will pay for energy, and establishes the framework for third party access to the electrical grid.

The schedule for phasing in third party access to electricity begins with the largest users, eventually covering all customers by the end of 2006. The timetable is as follows:

- The year 2002 will be the start of third party access; the largest customers (constituting about 40 gigawatt-hours [GWh], or roughly two-thirds of total consumption) will be able to select their electricity supplier.
- In 2003 another 9 GWh will be opened, followed by another 100 megawatt-hours [MWh] in 2005.
- By 2006, all customers will be able to choose their supplier.

Electricity Market Operator

The Electricity Market Operator is a joint-stock company, founded by the government, with inscribed shares. It prepares balances of the supply of and consumption for electricity for the specified periods on the basis of electricity supply contracts between generators, the transmission system operator, distribution systems operators, eligible customers, and traders and submits the balances to the transmission system operator and the distribution systems operators.

Czech Energy Agency (CEA)

The Czech Energy Agency is responsible for energy efficiency projects, new technologies, and renewables.

Czech Energy Works (Ceske Energeticke Zavody [CEZ])

Formed in 1992 following the separation of Czechoslovakia, CEZ is two-thirds owned by the National Property Fund. The state monopoly produces more than three-quarters of the electricity generated in the Czech Republic, handles import and export of electricity, and presently also operates the 220 kV and 400 kV grids via its subsidiary.

On 24 August 2001, the Government of the Czech Republic published a request for expressions of interest in the sale of 64% of CEZ, along with municipal shares in six regional distribution companies. State-owned minority shares in two additional distribution companies will be sold separately. Deloitte & Touche will evaluate tentative letters of intent and selected potential investors will be invited to take part in the second part of the tender (CEEBICnet, 2001).

Four groups are in the running to purchase the CEZ package: Belgium's Tractebel; British-based International Power and NRG Energy of the United States; a partnership of Italy's Enel and Spain's Iberdrola; and France's Electricite de France (EDF) and Energie Baden-Wurttemberg (*Prague Business Journal*, 10 October 2001).

According to the U.S. Embassy, the Czech Government is placing onerous requirements on the sale of CEZ, including that the company be maintained whole for ten years after purchase. There are also rumors that the process is designed to favor EDF. The Government is determined to sell the company as quickly as possible in light of its urgent need for cash to finance its growing budget deficit (Cable, #2985/01-261602Z November 2001, American Embassy Prague).

The two primary laws related to the energy sector are the Energy Act and the Energy Management Act.

<u>Act on Business Conditions and Public Administration in the Energy Sectors and on Amendment to Other Laws ([the "Energy Act"], Act 458, 28 November 2000)</u>

Effective 1 January 2001, the Energy Act provides the conditions for business activities, performance of public administration and regulation in the energy sectors, including electricity, gas and heat, as well as the rights of and obligations of individuals and legal entities. It brings Czech energy generation and distribution standards nearer to those of the EU. It incorporates into the Czech legal system the EU directives on common electricity and gas market rules, lays a new legal basis for business and regulation in the energy sector, creates a self-governed regulator of Czech energy grids, and sets the pace of gradual liberalization of the electricity and gas market.

The Act envisages liberalization of 30% of the country's electricity market in 2002, increasing the share of the market open to competition to 50% by 2005 and 100% by 2006.

To obtain a license, a individual or legal entity shall provide evidence of having sufficient funds and technical background for performing the licensed activities and evidence to prove that the performance of such activities will not lead to any threat to the lives and health of persons, to any property or any environmental interests. Availability of sufficient funds shall be proved by submitting:

- Evidence of business property,
- Evidence of net business property,
- Evidence of the volume of available funds, including the balances of bank accounts and loans,
- Most recent audited financial statements, including long-form notes thereto, if the applicant has pursued business activities in the previous fiscal period, and
- A business plan for the first 5 years of business activities in the energy-related areas.

Availability of sufficient funds is not required for licences for electricity generation from renewable resources and applicants for licences for heat generation from renewable resources, unless the installed capacity of the electricity-generating equipment is greater than 200 kW or the installed capacity of the heat-generating equipment is greater than 1 MWt.

In addition, electricity generated from renewable sources enjoys priority right of transmission.

The business plan shall contain evidence of:

- The applicant's characteristics,
- Ability to finance the business plan on a long-term basis,
- Expected costs and revenues,
- Ownership relation towards the equipment serving to perform the licensed activities,
- Basic technical and material-related conditions for the activities to be performed, including, but not limited to, equipment capacity, raw material consumption, delivery of products, and
- Balance of the applicant's finance.

Licenses are granted for up to 25 years for electricity and heat generation. The ERO grants licenses.

<u>Act on Energy Management (Act No. 406, 25 October 2000)</u>

Effective 1 January 2001, the Energy Management Act stipulates the rights and obligations of natural and legal persons in the management of energy, in particular electricity and heat, as well as gas and other fuels.

Section 5 of the Act discusses the "National Program for Economical Energy Management and Use of Renewable and Secondary Energy Sources" which promotes greater use of renewable energy sources. Under the program, subsidies may be granted from the national budget in support of *inter alia* development of combined heat and power generation; promotion of the use of renewable and secondary energy sources; science, research and development in the field of energy management; and drafting Territorial Energy Policies.

Tariffs

Electricity prices in the Czech Republic will increase annually by an average of 15% from 2000-2003. After 2003, market prices should be reached and the government will cease regulating prices.

The increase of residential electricity prices varies according to yearly consumption and use of electricity. The highest increase of 20% will be applied to households that use electricity only for appliances (excluding electric heating). The price in this category will be 7.45¢/kWh.

An approximately 15% increase (6.6¢/kWh) will be applied to households with electric accumulation heating.

Foreign Investment

In addition to a relatively stable political and economic environment and a well-qualified labor force, the Czech government offers attractive incentives for foreign direct investment. Legally, foreign and domestic investors are treated equally. The U.S. is currently the fourth largest investor in the Czech Republic, behind the Netherlands, Germany, and Austria.

<u>Act of Investment Incentives (24 February 2000)</u>

The Investment Act offers the following incentives:

1. Tax holiday of 10 years for new companies and five years for expansions of existing companies;
2. Job creation grants in regions with a high unemployment rate (up to US$ 5,000 for each new job);
3. Training and retraining grants in regions with high unemployment (up to 35% of training cost); and
4. Location incentives, including the provision of low-cost development land. In addition, municipalities receive subsidies for the development of infrastructure on location sites.

Addtional incentives, not covered by the new law are:

1. Duty free import of machinery and equipment;
2. Job-creation, training and retraining grants available directly from local labor offices;
3. Regional investment subsidies intended for job creation in depressed regions; and
4. Support for small companies.

Potential investors may contact CzechInvest to request an Investment Incentives Manual that describes all the current eligibility criteria, specific conditions, and application procedures:

CzechInvest
Stepánská 15
120 00 Prague, Czech Republic
Email: marketing@czechinvest.org
Web site: www.czechinvest.org

Personal ownership of real estate by foreign individuals and companies is not permitted in the Czech Republic. This restriction also applies to Czech branch offices of foreign entities. Czech legal entities, including 100% foreign-owned subsidiaries, may own real estate.

The Czech commercial code and a civil code are based largely on the German system. The commercial code details rules pertaining to legal entities and is analogous to corporate law in the United States.

No Specific Law for Geothermal

The Czech Republic has no specific geothermal legislation. No guidelines exist for geothermal exploration permits or licensing geothermal exploitation.

Geothermal Sites / Projects

The Czech Republic is composed of several distinct physical regions. The Bohemian Highlands in the western part of the country are bordered on the northeast by the Sudeten Mountains, on the northwest by the Ore Mountains (Krusne hory), and on the west by the Bohemian Forest (Cesky les) and Sumava Mountains. The eastern part of the country contains the Moravian Lowlands.

The territory of the Czech Republic consists of two geological structures: the Bohemian Massif and a part of Carpathian system (eastern Moravia). The Bohemian Massif represents an old consolidated basement which is formed by Proterozoic and Paleozoic crystalline rocks. The West Carpathian unit is in general younger and is represented by the nappe structure of alpine type.

The most promising geothermal areas are:

1. Foreland fault of Erzgebirge,
2. The axial and western part of the Bohemian Cretaceous Basin, and
3. West Carpathian Foredeep from the Vienna Basin up to the Ostrava region in North Moravia.

Tertiary basins in the foreland of Erzgebirge show heat flow of more than 100 $mWm^{-2.}$ The Foredeep on the border of the Bohemian Massif and West Carpathians has heat flow rates up to 90 mWm^{-2}. The average value of heat flow in the Bohemian Massif is about 60 mWm^{-2} (Myslil and Stibitz, 2000).

The Bohemian Massif contains ten geothermal areas with yields totaling 150 l/sec. Temperatures at a depth of 1000 m are 25-40ºC; natural springs have a temperature up to 70ºC. The heat flow value is 40-80 mWm^{-2} (Cermak and Kral, 1989). The heat power of thermal waters in the massif is up to 20 x 106 kcal/hr. Geothermal activity is most intense in the northwestern part of the massif and in the area of the Cretaceous basin (Franko et al., 1990; Franko, 1964; Franko and Racicky, 1975).

Low enthalpy geothermal resources have been used for centuries for balneology, domestic and swimming pool water heating, and small industry. The famous Czech thermal spas of Karlsbad and Marienbad have been popular for half a century.

The Czech Republic may not have lost all its high enthalpy geothermal resources to Slovakia when the country split in two. Estimates (Yoder and Tilley, 1962) indicate that regions of the Carpathians may have temperatures as high as 400ºC between 4 and 10 km.

Similarly, regions of the Bohemian massif may reach 200ºC at 7 km (Lawrence and Stoyanov, 1996).

Currently, the Czech Republic has an geothermal direct use installed capacity of 12.5 MWt producing 128 TJ/yr of energy. Total utilization is 36 GWh/yr; the capacity factor is 33% (Lund and Freeston, 2000). The country has a total of 3,300 MWt in unexploited, probable, and possible resources.

The Czech Republic has no electricity generated from geothermal resources.

The **Database of Geothermal Resources in Eastern Europe** contains information on 19 specific geothermal sites or projects in the Czech Republic. See Table 3 for a complete listing of the sites, their development status, temperature (ºC), and electric power generation potential. A complete description of each site, to the extent information is available, is included in the Appendix.

The Czech Republic's highest enthalpy geothermal resource identified to date is Karlovy Vary (Karlsbad) with a temperature of 72ºC. The average temperature of all sites is 13.2ºC. No sites have a temperature of 100ºC or more.

Site/Project Name	Status	Temperature (ºC)
Becvou	Preliminary identification/report	22
Bludov Lazne	Preliminary identification/report	28
Bozi Dar	Prefeasibility study	—
Breclav	Feasibility study	—
Darkov	Direct use -- developed	28
Decin	Direct use -- developed	—
Doupovske vrchy	Prefeasibility study	—
Jachmyov	Direct use -- developed	28-32
Janske Lazne	Direct use -- developed	18-32

Site/Project Name	Status	Temperature (ºC)
Karlovy Vary (Karlsbad)	Direct use -- developed	35-72
Marianske Lazn (Marienbad)	Direct use -- developed	—
Musov	Preliminary identification/report	—
Pisek	Preliminary identification/report	—
Prokop	Direct use -- developed	28
Slatinice	Preliminary identification/report	21
Strekov	Direct use -- developed	—
Teplice	Direct use -- developed	42-46
Trekov	Preliminary identification/report	—
Velke Losiny	Direct use -- developed	34-36

Table 3 – Geothermal Resources in the Czech Republic

Base 802237 (R01307) 6-94

Romania

Power Profile

Population (millions) -July 2000 estimated	22.36
GDP (billion US$) - 2000 estimated	132.5
Real GDP Growth Rate - 2001 estimated	3.6%
Inflation Rate (CPI) - 2000 estimated	45.7%
Total Installed Capacity (MWe) - January 2000	22,190
Electricity Consumption per Capita (kWh) - 2000	1,937
Energy Demand Growth Rate	2.5%
Prices (US¢/kWh) – countrywide averages, 2000 Residential Industrial Source: EBRD, *Transition report 2001*	 4.9 3.9
Geothermal Power Potential (MWe)	200
Geothermal Direct Use Potential (MWt)	480

Situated north of the Balkan peninsula in the Lower Danube basin and bordering the Black Sea, Romania is the second largest market in Central and Eastern Europe. Slightly smaller than Oregon, it is bordered by Ukraine to the north, Moldova and Ukraine to the northeast, Hungary to the northwest, Yugoslavia to the southwest, Bulgaria to the south, and the Black Sea to the east.

Romania became part of the Soviet Bloc after World War II. The decades-long rule of President Nicolae Ceausescu became increasingly draconian through the 1980s. He was overthrown and executed in late 1989. Former communists dominated the government until 1996.

In February 1997, Romania embarked on a comprehensive macroeconomic stabilization and structural reform program, but reform subsequently has been a frustrating stop-and-go process. In 1999, the country sustained an estimated US$ 700 million in losses during the Kosovo conflict due to disrupted trade, transport, and investment.

In the November 2000 elections, the ex-communist Party of Social Democracy in Romania (PDSR)'s Ion Iliescu won the presidency. The new government has expressed its commitment to accelerating reforms, including the privatization of utilities. It has pledged to cut inflation to under 10%, step up reforms, and reduce poverty.[4] The

4 Forty percent of the population lives below the poverty line.

government's primary aim, however, is to ensure a smooth accession to the EU (Reuters Limited, 2001).

After three years of recession, Romania's economy is rebounding. In the first half of 2001, Romania achieved the highest economic growth in the region. Romanian officials are forecasting growth of 4.5% in 2001 and 5.0% in 2002 (PlanEcon, 2001). The World Bank has stated that, if accelerated reforms continue, it will adopt a high-case lending scenario, increasing its commitments to Romania to US$ 995 million through 2004.

Much remains to be done, however, with the private sector accounting for only 62% of GDP.

Romania is a member of CEFTA, the World Trade Organization, and the Council of Europe. In 1993, Romania had its Most Favored Nation Status with the United States restored on a permanent basis. In 1994, Romania was the first Eastern European State to sign the NATO Partnership for Peace in Brussels.

Power Summary

Romania has a total installed capacity of 22,190 MWe. Thermal power accounts for approximately 70% of the total, hydropower 27%, and nuclear power 3%. Approximately 60% of Romania's existing power capacity is more than 20 years old; 10 GW will need to be rehabilitated or replaced by 2010. The Romanian energy sector will require at least US$ 15 billion in investment over the next decade.

Romania is an important regional oil and gas producer, as well as a potential transit site for energy exports from the Caspian and Caucasus regions. The country has crude oil reserves of about 1.4 billion barrels and proven natural gas reserves estimated at 13.2 trillion cubic feet, enough for about 25 years at the current consumption rate.

Despite its sizeable fossil fuel reserves–the largest proven petroleum reserves and refining industry in eastern Europe–due to obsolete equipment and a slow-down of investment in exploration and production Romania has become a net-importer of crude oil and gas. The Romanian government has committed itself to reverse this situation, increasing domestic production of oil and gas to reduce the country's reliance on imports.

Romania has estimated coal reserves of 3.98 billion short tons, primarily lignite and sub-bituminous coal. The coal industry in Romania has fallen on hard times since the revolution in 1989, suffering a 57% decline in production, outdated infrastructure, and labor unrest.

With its many rivers, Romania has about 40 terawatt-hours (TWh) per year of hydroelectric power potential; 12 TWh per year have been developed. About 5,000 locations are good candidates for small hydropower plants.

Romania's sole nuclear power plant is located 90 miles east of Bucharest. The 750-MWe Cernavada 1 unit, the first Western-designed nuclear reactor in Eastern Europe, was commissioned in December 1996. The 700-MWe Cernavoda 2 unit, which is about 40% complete, is expected to be commissioned in 2005. Cernavoda 3 is 15% complete, Cernavoda 4 is 5% complete, and Cernavoda 5 is 4% complete. Further construction of units 3, 4, and 5 is pending financing.

While renewable energy sources, e.g., biomass and waste incineration, contribute a small amount to the Romanian grid, the government intends to develop renewable sources. The primary markets for renewable energy applications are seen as villages and medium-sized towns, or 61% of the total population. Phare has funded a successful geothermal project.

Romania's demand for electricity is expected to increase to 54.2 TWh in 2010. Industrial demand for energy is decreasing while residential demand is increasing.

Romania is a net electricity exporter. The Romanian grid operator is working to become more fully integrated into the UCPTE system[5] to increase its exports even more.

[5] The Union for Power Production and Transport Coordination (UCPTE) is a non-governmental organization that brings together the power systems of 15 Western European countries.

Government / Legislation

Romania began to de-monopolize its electric power sector in late 1999 with the restructuring of the Romanian Regie Autonomous for Electricity (RENEL), the former vertically integrated monopoly. This resulted in the creation of CONEL, the National Electricity Company. CONEL was further broken up into four companies in 2000. The government is preparing strategies for the sale of some of CONEL's successors, in particular in the electricity distribution sector. Generating companies with thermal power plants and distribution companies will be privatized. IPPs will be allowed.

In February 2000, Romania opened up 10% of its energy market by allowing ten large industrial companies to choose their own electricity supplier and granting electricity supply licences to five local independent producers. In October 2000, the government decided to increase the degree of liberalization to 15%.

In late September 2001, Prime Minister Nastase said that the government would now concentrate on privatizations in the energy sector, pledging to speed up the sale of utilities in 2002 (PlanEcon, 2001).

The ultimate goal of the process is to create a fully competitive electricity pool system in which all players compete with each other, including power importers, autoproducers, and power distributors.

Ministry of Industry and Trade

The Ministry of Industry and Trade supervises the energy sector, and formulates policy and the National Energy Development Strategy which analyzes the development of the energy sector in the next 20-25 years. The strategy calls for the government to:

- Increase the use of natural gas;
- Reduce the weight of coal-based electricity and heat production;
- Promote energy saving;
- Diversify the energy supply sources and supply of energy sources;
- Extend international cooperation in the energy sector;
- Liberalize the energy sector;
- Eliminate subsidies in the energy sector;
- Harmonize the energy related legislation to the EU standards and to the Energy Charter Treaty;
- Promote investments in the energy sector; and
- Promote environmental protection.

National Electricity Company (CONEL)

Created in 1998 as successor to RENEL, CONEL is responsible for electricity transmission, and is the system and market operator.

CONEL was broken up into four wholly owned subsidiaries: Transelectrica S.A., for electricity transmission and dispatching; Termoelectrica S.A., for electricity and heat generation in thermal power plants; Hidroelectrica S.A., for electricity generation in hydropower plants; and Electrica S.A., for electricity distribution and supply.

Transelectrica is also the sole shareholder in a separate company named Opcom S.A. which is responsible for the local energy market and electricity transport through eight branches across Romania.

Electrica will be split into eight units that will be privatized gradually as of 2002, while joint ventures will be created with foreign partners.

CONEL's successor companies supply about 8.2 million customers and account for 96.7% of electricity produced in Romania. Each of these companies is state-owned, with the state represented by the Ministry of Industry and Trade.

CONEL has received technical assistance through the Utility Partnership Program, supported by the U.S. Agency for International Development (USAID) and the United States Energy Association.

National Electric and Heat Regulatory Authority (ANRE)

The economic and technical operation and development of the electricity sector is regulated, ruled, supervised and monitored by the National Electricity and Heat Regulatory Authority which was set up by an Emergency Ordinance in October 1998 as an independent and autonomous public institution.

National Agency for Mineral Resources (NAMR)

NAMR was established in 1993 as the regulatory authority to administer the mineral resources of Romania and is under government subordination. It is the competent authority which coordinates the mining operations under Petroleum and Mining Laws. NAMR has the following responsibilities:

- To administer and survey Romanian mineral resources, the national geologic fund, and all national property;

- To compute, register, and update all mineral resources of Romania in the Mining Book and Petroleum Book;

- To negotiate the terms and conclude agreements for the exploration and production of mineral resources;

- To regulate the activities and operations on the basis of these or of any other agreements;

- To establish legal taxes, royalties, and prices for prospecting exploration and production activities, as well as pipeline transport tariffs for hydrocarbons; and

- To issue compulsory regulations and instructions for the mineral resources sector.

In addition, NAMR selects, finances, and follows up on all geological exploration and exploitation works for geothermal resources.

All data and information, irrespective of their manner of storage, concerning the Romanian mineral resources, shall be submitted to NAMR and belong to the Romanian State.

NAMR publishes a list containing the perimeters under administration or concession for exploration in the *Official Monitor*, within maximum 30 days upon the request.

36-38, Mendeleev St., Sector 1,
Bucharest, Romania, 70169
Phone: (401) 313 22 04
Fax: (401) 210 70 40
Email: namr@namr.ro
Website: http://www.namr.ro

The Romanian Constitution, adopted in 1991, stipulates that "resources of any nature occurring in the underground, [and] the water with useful energy content, etc., are exclusively public property." Mineral rights are excluded from private ownership.

The primary legislation which covers the electricity sector are the :

- Mining Law (No. 61/1998),
- Water Law (No. 107/1996),
- Emergency Ordinance on Foreign Investments (No. 31/1997),
- Law of Concession (No. 219/1998), and
- Law of Competition (No. 21/1996).

Mining Law (No. 61/1998)

The Mining Law regulates mining activities in Romania, and stimulates the capitalization of mineral resources, which are public property. The Law assures maximum transparency of mining activities and fair competition, without discrimination based on property forms, the origin of capital, or the nationality of the operators. Investments in mining are encouraged by fiscal and administrative facilities, and are free of any constraint on return on investment or profits. The Mining Law considers as mineral resources "heating from hydrogeothermal systems, mineral and flat waters, [and] mineral-thermal waters."

Exploration shall be conducted on the basis of an exclusive license, issued at the request, to the interested Romanian or foreign legal persons selected through a semestrial public offering by the NAMR, based on a work program and an adequate bank guaranty to be applied for environmental restoration purpose.

Prospecting permits may be issued for a maximum of three years, and do not assure any exploration or exploitation rights. Exploration licenses may be granted for a maximum of five years, with a renewal right of no more than three years. An annual fee must be paid in advance. The titleholder of an exploration license has the right to obtain upon request the exploitation license for any mineral resources discovered.

An exploitation license shall be granted to the titleholder of the exploration license on its request, or the winner of a public offering organized by the NAMR. It shall be granted through negotiation, based on an application accompanied by:

1. A feasibility study which ensures the capitalization of the mineral resources and the deposit protection;

2. A development plan for exploitation;

3. An environmental impact study, approved according to the law; and

4. An environmental rehabilitation plan accompanied by a bank guarantee, based on the value of the development plan and the environmental impact study, and calculated according to norms for applying the present law.

An exploitation license will be granted for a maximum of 20 years with the right of continuation for successive periods of 5 years each. The titleholder of the exploitation license will pay an annual tax on surface and a mining royalty, according to the present law.

Water Law (No. 107/1996)

The Water Law regulates the use and protection of Romania's water resources.

Emergency Ordinance on Foreign Investments (No. 31/1997)

The Emergency Ordinance defines the rights of foreign investors and the terms and conditions for foreign investments in Romania. The new legislation maintains the provisions for national treatment and free access to the domestic markets, protection of foreign investment, dispute settlement, and transfer of funds.

Foreign investors have the same rights to access to real estate in Romania except the right to own land.

Law of Concession (No.219/1998)

NAMR issues public tenders for obtaining concession licenses for exploitation.

Law of Competition (No. 21/1996)

The Law of Competition, ensures competition on the Romanian market. The Competition office is set up and is subordinated to the government.

Tariffs

Romanian electricity prices are currently the lowest in Europe, less than 70% the average EU-member country price. ANRE sets electricity tariffs which must be approved by the government. In July 2001, at ANRE's request the Cabinet of Ministers agreed to raise electricity tariffs by 15%.

Electricity tariffs will be increased on a monthly basis in line with the leu/euro exchange rate (PlanEcon, 2001). Further price adjustments will result when the Romanian energy system is connected with the European energy transport system effective 1 January 2002.

A consequence of the increase in electricity prices could be the bankruptcy of thousands of commercial companies, which would no longer be able to pay their bills. The government will address this problem by establishing differentiated prices for consumers and subsidies to cushion price hikes.

Foreign Investment

Attracting foreign direct investment is key to re-launching the Romanian economy and meeting the conditions for country's integration into Euro-Atlantic structures and EU accession.

FDI in Romania has been low by international standards. Taxes, regulations, and policy instability are ranked by foreign investors as the most serious obstacles to business. To improve the business environment, Romania's legal framework should be stabilized through less frequent changes to laws, and corruption should be tackled vigorously (*EBRD Transition report*, 2001). The United States was the fourth major investor in the country with a total investment volume of US $663 million in 2000.

<u>Draft Law on Investment (2001)</u>

The new Romanian investment law was finalized in June 2001. The bill attempts to rectify past errors by enshrining four basic principles into its new legislative framework: stability, balance, non-discrimination, and efficiency. [6]

The bill refers only to direct investments with a significant impact on the economy, which are defined as investments over US$ 1 million, and which bring a marked contribution to the economic growth and development of Romania, to the preservation of existing jobs and the creation of new ones.

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[6] A fuller description of the Law can be found at http://www.hr.ro/rdwp/digest6_2001.pdf.

Direct impact investments are permitted in all sectors of the Romanian economy, except for those regulated by special laws (such as strategic sectors). Restrictions are provided only with regard to investments that may affect the environment, Romania's national security and defense, public order, health, and morality.

A potential obstacle for U.S. exporters is the preferential tariff treatment for European competitors. The free trade arrangements with the EU, EFTA, and CEFTA are already triggering customs duty discrimination against some U.S. products (Country Commercial Guide, 2001).

The Romanian Government also offers concessions made in "disadvantaged zones," e.g., regions with high unemployment due to heavy restructuring. Concessions in these are include: full restitution of import duties for depreciable goods; exemption from profit tax; exemption from any fees associated with the re-zoning of agricultural land for industrial purposes; and access to a special development fund for stimulating exports, guaranteeing external credits, financing special programs and state-sponsored equity investments.

<u>No Specific Law for Geothermal</u>

Romania has no specific geothermal legislation. Guidelines exist for geothermal exploration permits and licensing geothermal exploitation. Geothermal licensing is issued by the state.

The Government of Romania supports investment in geothermal projects through reduction of customs duties; provision of land or facilities; free utilization of existing wells; and royalties, prices, and tariffs.

Geothermal Sites / Projects

Romania is composed of three geographic areas. The Transylvanian basin in the central part of the country is an area of hilly (300-600 m elevation) fertile soils developed on beds of sand, marl, and clay overlain by loess and alluvium. The second region is the plains that ring the entire country except in the north, and are separated from the mountains by hilly piedmonts. The third region is the Carpathian Mountains which circle the Transylvanian basin.

The Eastern Carpathians run southeast from the Ukrainian border toward their junction with the Southern Carpathians at Brasov. Their eastern section has significant seismic activity, and is the source of frequent destructive earthquakes. The higher and more rugged Southern Carpathians, or Transylvanian Alps, run west from Brasov to the Serbian border and reach 2543 m at Mount Moldoveanu, the country's highest elevation. The Western Carpathians, a south-to-north line of three geologically complex massifs, extend from the Danube to the Somes River.

Romania has six distinct hydrogeothermal systems: four in the Pannonian Basin in western Romania; one in the gorge of the Olt River in the middle of the Southern Carpathians within the Getic Depression; and one in the Moesian Platform north of Bucharest in the southern part of the country.

Most of Romania's geothermal resources are located along the border with Hungary and northern Serbia, in the porous and permeable sandstones and silt stones of the Western Plain (structurally part of the Pannonian Basin) and Olt Valley, and in the fractured carbonate formations of Oradea, Bors, and North Bucharest (Cohut and Bendea, 2000).

The Pannonian geothermal aquifer is multilayered, confined, and located in the sandstones at the basement of the Upper Pannonian in an approximate area of 2500 km^2 along the Western border of Romania. The aquifer is situated at the depth of 800-2100 m. Eighty geothermal wells have been drilled in the aquifer; 37 are currently exploited. The thermal gradient is 45-55°C/km. The water temperature at surface is 50-85ºC. Most of the waters show carbonate scaling. The exploitable heat reserves for the next 20 years are estimated to be over 95,000 TJ with the existing wells and generalized downhole pumping exploitation (Cohut and Bendea, 1999).

The Oradea geothermal reservoir is located in the Triassic limestone and dolomites at depths of 2200-3200 m on an area of about 75 km^2. Twelve wells with a total artesian now rate of 140 Vs and wellhead temperatures of 70-105°C have been drilled. There are no dissolved gases and the mineralization is lower than 1.2 g/l. Although there is a significant recharge of the geothermal system, the exploitation with a total now rate of over 300 Vs generates pressure draw down in the system, that may be prevented by reinjection.

The Bors geothermal reservoir is 6 km northwest of Oradea in the same fissured carbonate formations. This is a tectonic closed aquifer with a small surface area of 12 km^2. The geothermal water has a mineralization of 13 g/l and a high scaling potential. The artesian production of the wells can be maintained only through reinjection. At present, three wells are exploited, with a total flow rate of 50 l/s. Two other wells are used for reinjection. The wells are producing with wellhead pressures of 10-15 bar and a wellhead temperature of 115°C.

The first geothermal well in Romania was drilled in 1885 at Felix Spa, near Oradea. Following World War II, geothermal resources were found in the course of oil and gas exploration.

In 1962, geothermal exploration began in earnest under the state-funded Geological Research Program. In 1983, the government created nine new companies for geological surveys and exploration. In 1990, autonomous trade companies for research and exploration of mineral resources were established (Panu, 1995).

The oil crisis of the early 1970s gave additional encouragement to the direct heat utilization of the geothermal resources. Many direct use geothermal operations were built between 1975 and 1990.

In 1976-1986, the United Nations Development Programme (UNDP) contributed to the investigation and reevaluation of geothermal energy within the framework of an agreement with the Romanian Government. Due to economic difficulties, only three new geothermal projects were completed during 1995-1999.

At present, over 200 wells have been drilled in Romania, proving the existence of low enthalpy geothermal resources with temperatures of 40-120°C. Proven geothermal reserves in Romania are currently about 200,000 TJ for 20 years (Cohut and Bendea, 2000). Only about 30% of the resources identified and confirmed by geothermal wells are currently in use. The main obstacle to geothermal development in Romania is the scarcity of domestic investment capital.

Romania has an installed capacity of 152.4 MWt producing 2,871 TJ/yr of energy. Total flow is 890 kg/s; utilization is 797 GWh/yr; the capacity factor is 60%. To date, 181 person-years and US$ 24 million have been invested in geothermal development (Lund and Freeston, 2000). The country has 480 MWt of proven geothermal resources.

The main direct uses of geothermal energy are space and district heating (37%), bathing (30%), greenhouse heating (23%), industrial process heat (7%), and fish farming and animal husbandry (2%).

Romania's potential markets for geothermal are district heating, greenhouses and agriculture, health spas, swimming pools, and cascaded uses, and to a lesser extent

–fish farming, industrial processes, and combined space heating and cooling.

The Romanian government wants to add onto existing district heating supply systems in cities near geothermal fields, as well as develop new district heating systems for smaller towns and large villages and thermal applications for industrial or agricultural uses.

Work has been done on utilizing geothermal resources for power generation. In 1981, the National Geothermal Research Institute designed and developed a binary 2 MWe geothermal electric power plant for Oradea using CO_2 as the working fluid. In 1996, a new pilot power plant was designed using a turbine instead of a piston. The 2 MWe power plants are experimental and used for testing only during the warm period of the year when more geothermal water is available for the evaporator (Mircea and Cornel, 2000).

Romania's estimated power generation potential is 200 MWe.[7]

The **Database of Geothermal Resources in Eastern Europe** contains information on 72 specific geothermal sites or projects in Romania. See Table 4 for a complete listing of the sites, their development status, temperature (ºC), and electric power generation potential. A complete description of each site, to the extent information is available, is included in the Appendix.

Romania's highest enthalpy geothermal resource identified to date is Tusnad-Bai with a temperature of 300ºC. The average temperature of all sites is 53.5ºC. Five sites have a temperature of 100ºC or more.

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7 Geothermal Energy Association, *Preliminary Report: Geothermal Energy, the Potential for Clean Power from the Earth* (Washington, D.C., April 1999).

Site/Project Name	Status	Temperature (ºC)
Acas	Direct use -- developed	65-90
Alesd	Direct use -- developed	52
Arad	Direct use -- developed	40-42
Aviatiei	Well(s) or hole(s) drilled	—
Avitim	Well(s) or hole(s) drilled	51
Balotesti	Well(s) or hole(s) drilled	74
Beius	Direct use -- developed	83
Beltiug	Direct use -- developed	75
Berecsau Mic	Preliminary identification/report	77
Beregsau	Direct use -- developed	75
Boghis	Direct use -- developed	45-48
Bors	Direct use -- developed	90-135
Braila	Preliminary identification/report	—
Brasov	Preliminary identification/report	—
Buftea	Well(s) or hole(s) drilled	40
Caciulata	Direct use -- developed	37
Calacea	Preliminary identification/report	—
Calimanesti	Direct use -- developed	90-95
Carei	Direct use -- developed	45-90
Cighid	Direct use -- developed	72-86

Site/Project Name	Status	Temperature (ºC)
Ciumeghiu	Direct use -- developed	84-120
Cluj-Napoca	Preliminary identification/report	—
Comlosu	Direct use -- developed	81-85
Constanta	Preliminary identification/report	—
Covaci	Well(s) or hole(s) drilled	53
Cozia	Direct use -- developed	90-95
Craiova	Preliminary identification/report	—
Curtici	Direct use -- developed	63-65
Dorobanti	Direct use -- developed	60-74
Felix Spa	Direct use -- developed	34-49
Galati	Preliminary identification/report	—
Geoagiu	Direct use -- developed	—
Grabat	Direct use -- developed	80-88
Herculane	Direct use -- developed	52-70
Iasi	Preliminary identification/report	—
Insuratei	Well(s) or hole(s) drilled	60
Iratos	Direct use -- developed	40-64
Jimbolia	Direct use -- developed	82-88
Lenauheim	Preliminary identification/report	82
Livada	Direct use -- developed	88-107

Site/Project Name	Status	Temperature (ºC)
Lovrin	Direct use -- developed	81-91
Macea	Direct use -- developed	65-72
Madaras	Direct use -- developed	46-62
Mangalia	Preliminary identification/report	—
Marghita	Direct use -- developed	65-85
Mihai Bravu	Direct use -- developed	60-65
Moara Vlasiei	Well(s) or hole(s) drilled	76-78
Nadlac	Direct use -- developed	78-84
North Bucharest	Direct use -- developed	62-85
Olanesti	Well(s) or hole(s) drilled	90-92
Olt Valey	Direct use -- developed	92-98
Oradea	Direct use -- developed	29-105
Otopeni	Direct use -- developed	58-72
Periam	Direct use -- developed	58-80
Ploiesti	Preliminary identification/report	—
Sacuieni	Direct use -- developed	80-90
Salonta	Feasibility study	95
Sannicolau	Direct use -- developed	78-88
Santandrei	Well(s) or hole(s) drilled	150
Saravale	Direct use -- developed	75-90

Site/Project Name	Status	Temperature (ºC)
Satu Mare	Direct use -- developed	65-88
Semlac	Direct use -- developed	55-65
Snagov	Well(s) or hole(s) drilled	83
Sofronea	Direct use -- developed	42-70
Tasnad	Direct use -- developed	70-88
Teremia	Direct use -- developed	85-90
Timisoara	Direct use -- developed	31-60
Tomnatic	Direct use -- developed	80-84
Tusnad-Bai	Well(s) or hole(s) drilled	15-300
Varias	Direct use -- developed	65
Videle	Well(s) or hole(s) drilled	40
Zerind	Preliminary identification/report	98

Table 4 – Geothermal Resources in Romania


Romania
International boundary
County (județ) boundary
National capital
County (județ) center
Railroad
Expressway
Road
Bucuresti is a municipality (municipiu).
0 25 50 75 100 Kilometers
0 25 50 75 100 Miles
Lambert Conformal Conic Projection, SP 40N/56N
Serbia and Montenegro have asserted the formation of a joint independent state, but this entity has not been formally recognized as a state by the United States.
UKRAINE
SLOVAKIA
HUNGARY
MOLDOVA
BULGARIA
Serbia
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA
Vojvodina (autonomous province)
Kosovo (autonomous province)
Black Sea
Bucharest
Chisinău
Belgrade
Sofia
Skopje
BIHOR
ARAD
TIMIȘ
CARAȘ-SEVERIN
HUNEDOARA
ALBA
CLUJ
SĂLAJ
SATU MARE
MARAMUREȘ
BISTRIȚA-NĂSĂUD
SUCEAVA
BOTOȘANI
IAȘI
NEAMȚ
MUREȘ
HARGHITA
COVASNA
BACĂU
VASLUI
GALAȚI
VRANCEA
BRAȘOV
SIBIU
VÎLCEA
GORJ
MEHEDINȚI
DOLJ
OLT
ARGEȘ
TELEORMAN
GIURGIU
DÎMBOVIȚA
PRAHOVA
BUZĂU
BRĂILA
TULCEA
IALOMIȚA
CĂLĂRAȘI
CONSTANȚA
BUCUREȘTI
Danube
Base 802206 (R01144) 5-96

Slovakia

Power Profile

Population (millions) -July 2000 estimated	5.41
GDP (billion US$) - 2000 estimated	55.3
Real GDP Growth Rate - 2001 estimated	3.0%
Inflation Rate (CPI) - 2000 estimated	12.2%
Total Installed Capacity (MWe) - January 2000	6,952
Electricity Consumption per Capita (kWh) - 2000	4,828
Energy Demand Growth Rate	N/A
Prices (US¢/kWh) – countrywide averages, 2000 Residential Industrial Source: EBRD, *Transition report 2001*	 5.9 4.6
Geothermal Power Potential (MWe)	30
Geothermal Direct Use Potential (MWt)	5,538

Slovakia, or the Slovak Republic, joined the closely related Czechs to form Czechoslovakia in 1918. Following the chaos of World War II, Czechoslovakia became a communist nation within Soviet-ruled Eastern Europe. Soviet influence collapsed in 1989 and Czechoslovakia once more became free. The Slovaks and the Czechs agreed to separate peacefully on 1 January 1993. Slovakia has experienced more difficulty than the Czech Republic in developing a modern market economy (CIA).

Slovakia's rate of GDP growth slowed to 2.8% in the second quarter of 2001, down slightly from the 3.0% rate registered in the first quarter but up from 2.2% for 2000. Rising foreign investment, continued restructuring, and gains in productivity mean that Slovakia has good prospects for strong industrial output growth in the coming years (PlanEcon, 2001).

Slovakia is a member of the OECD, CEFTA, and is on the fast track toward NATO and EU membership. Slovakia began accession negotiations with the EU in March 2000, and hopes the join the union in 2003-2004.

Slovakia is approximately twice the size of New Hampshire. Landlocked, it is bordered by Austria, the Czech Republic, Hungary, Poland, and Ukraine.

Power Summary

Slovakia has a total installed capacity of 6,952 MWe. In 1999, 52.27% of the total electricity production of 32,943 GWh was obtained from nuclear power stations, 28.37% from fossil fuels, 19.36% from hydro stations, 8.5% from industrial power sources, 15.33% was imported, and 15.46% was exported.

The Slovak Republic is a net energy importer. In 1999, energy imports provided approximately 85% of Slovakia's energy supply. Slovakia has minor oil, natural gas, and coal resources, relying on oil and gas imports from Russia and coal imports from Russia, Ukraine, Poland, and the Czech Republic. It is committed to diversifying its energy sources by use of long-term energy supply contracts.

Much of the hydroelectric development in Slovakia is located in the Vah River valley, including its main tributary, the Orava River. There are now more than 20 hydroelectric power plants on the Vah River, with a total installed capacity of more than 1,600 MWe. Small hydropower plants produce 202 GWh annually, with an installed capacity of 45 MW. The potential of hydropower energy in Slovakia is 3,722 TJ.

Nuclear energy is an important component of Slovakia's current and future energy policy. The country currently has six operating nuclear power reactors at two nuclear power plant sites.

Renewable energy is underutilized in Slovakia. The share of renewable energy sources accounted for 3% of total primary energy consumption in 1995, compared to 19.3% in neighboring Austria where there are similar geographical conditions. The real potential of biomass energy is 33,041 TJ, of thermal solar energy–18,720 TJ, and of geothermal energy–22,680 TJ. Wind energy's potential is low.

Slovakia's energy consumption per unit of GDP is two to four times higher than that of developed countries. Once the country adopts free market-based practices, this figure should decrease as energy savings become more important.

Electricity consumption is increasing and is expected to increase more than 20% over 1997 levels by 2010. Electricity consumption forecasts over the next three years vary from 4 to 7 TWh (Volent, 2001).

Government / Legislation

Following several years of very little market reform, in 2000 the Slovak government took decisive steps, including introducing price adjustments, starting partial privatization, and drafting a liberalization plan for the electricity sector. The government is currently debating the reform of the energy sector, which would include the restructuring of existing companies, privatization to strategic investors and the establishment of an independent regulatory body (*EBRD Transition report*, 2001).

Ministry of Economy

The Ministry of Economy plays the leading role in energy planning, and is responsible for the country's electricity, generation, transmission, and distribution sectors. It issues licenses and approves the construction, renewal, or decommissioning of energy plants in compliance with the national energy policy.

The Office for Regulation of Network Industries will take over the energy control functions of the Ministry of the Economy on 1 January 2003.

Ministry of Finance

The Ministry of Finance regulates energy prices. Effective 1 January 2003, however, the Office for Regulation of Network Industries will assume the price-setting functions of the Ministry of Finance for electricity, natural gas, and district heating.

Ministry of Environment

The Ministry of Environment manages the country's geothermal resources.

Office for Regulation of Network Industries

The 1998 Law on Energy was amended in July 2001 to set up a regulatory body that would take effect 1 January 2003.

The Office for Regulation of Network Industries will take over the energy control functions of the Ministry of the Economy and the price-setting functions of the Ministry of Finance for electricity, natural gas, and district heating. It is expected that the funding for the Office will come from fees assessed on the companies being regulated.

Slovak Energy Agency (SEA)

SEA provides technical reports and analyses for the Ministry of Economy. In addition, it processes (based on the recommendation of the Ministry) materials from central state authorities, drafts the Slovak Energy Policy; develops (for the Ministry) materials for drafting price proposals, tariffs; and develops expert opinions and materials for decision making in the Ministry. It also develops regional energy concepts for local government authorities and identifies and reviews restrictions of the development of an enhanced rational use of renewable energy sources. SEA administers funds assigned to the Slovak Republic as a result of international aid programs, e.g., Phare, Save, Joule, Thermie, etc.

Slovak Energy Policy to 2005

Slovakia's new energy policy has three main aims: preparation for integration into European Union internal market; security of energy supply; and sustainable development. The policy calls for *inter alia*:

- An increase of energy consumption by renewable energy sources and other secondary sources (waste heat).;
- Support to domestic energy production to reduce imports of fuels;
- Combined heat and power production will be supported (1,000 MW by 2005);
- Competition in energy sector;
- Increased efficiency and wider use of renewables; and
- Guaranteed support for foreign investment in the Slovak energy sector.

Slovenske Elektrarne a.s. (SE).

The state-owned power utility SE is the primary generator and transmitter of electric power in Slovakia. Its responsibilities include: electricity generation and transmission; heat generation and delivery into the distribution network of heat suppliers; utilization of renewable energy sources and new forms of electricity; and international trade in electricity.

SE should be privatized in the first half of 2002. The government's plan for selling the electricity system calls in the first phase for splitting off three regional distribution companies, to be followed by their transformation into three power distribution and six heat production and distribution joint stock companies. The second phase of SE de-monopolization will split SE into three independent units as of November 2001.

The government's goal is to sell partial (44.79%) shares in each company by late 2001 or early 2002 (Country Commercial Guide, 2001). The government will retain ownership of the high-voltage transmission system and dispatching center.

Under current regulations, privately-financed construction of power plants to serve industrial users is permitted. However, any excess power must be sold to the grid, and any power generated from renewables must be sold to the grid. Direct "wheeling" of power to selected customers will be permitted when new energy liberalization rules take effect in January 2003.

National Agency for SME Development (NADSME)

NADSME was founded as a joint initiative of the EU's Phare program and the Government of the Slovak Republic. Its main mission is to initiate the development and growth of the existing and newly formed small and medium enterprises in Slovakia. It coordinates all activities directed towards providing support to small and medium enterprises, including financial, at an international, national or local level.

The Slovak energy sector is expected to be fully compatible and competitive in European energy market by 2003, its expected accession date into the EU. Accession into European Union requires restructuring the energy sector, new principle of regulation in energy sector, price adjustment, liberalization, and opening the market.

Slovakia plans to harmonize its energy laws with the EU and to eventually eliminate cross-subsidization. The primary legislation which governs the Slovak Republic electricity sector is the Energy Law.

Energy Law No.70/1998

The objectives of the Law on Energy are to stimulate a competitive environment in the energy sector, in-part by redefining the role of the state in the energy industry; to protect consumers; and to ensure reliable, economical, and high-quality power supplies.

The Law approximates energy laws of the EU. It sets forth the conditions of doing business in the electric utility, gas, and district heating sectors; and defines the rights and obligations of organizations doing business in the energy sector.

The Law was amended in July 2001 to create the Office for Regulation of Network Industries.

Tariffs

Slovakia has gradually raised household electricity prices over the past several years. Industrial and residential electricity prices were 4.1¢/kWh and 4.3¢/kWh respectively in 2000, up from 3.1¢/kWh and 1.6¢/kWh in 1993. In February 2001, the government increased prices again by 17% on average. By January 2004, prices must be in line with standard regulated prices in the EU.

Effective 1 January 2003, the Office for Regulation of Network Industries will begin setting electricity prices.

Foreign Investment

FDI inflows to Slovakia have been relatively low, but with the introduction of new policies the situation is likely to change. The government has made attracting foreign direct investment one of its priorities and has approved an extension of its incentive package. Foreign investors' participation in the privatization process is also being encouraged, based on transparent and predictable rules and regulations (*EBRD Transition report*, 2001).

The following legislation promotes foreign investment in Slovakia.

Foreign Investment Tax Credit (Act No 466/2000 Coll.)

This law provides all qualified taxpayers with a 100% tax holiday for the first five years of operation in Slovakia, starting with the first profitable year. In the subsequent five years, qualified taxpayers will receive a 50% tax holiday if the taxpayer increases the registered capital.

To qualify for the foreign investment tax credit, an applicant must meet two sets of criteria. The first requires a foreign paid-in contribution to registered capital of at least 60% of the total during the entire period of the tax holiday, that taxpayer revenues must be at least 60% of total revenues for the entire tax holiday, that the taxpayer be registered in the Commercial Register before 31 December 2003, and that the taxpayer be a legal entity with either its seat in Slovakia, or be a branch of a foreign entity located in Slovakia. The second set of criteria sets different qualification requirements (primarily in terms of the minimum contribution to registered capital) for taxpayers, based on the type and location of their activities.

Strategic Investors' Tax Law

Under the Strategic Investors' Tax Law, qualified applicants are defined as those which create a new place of business, or upgrade an existing place of business or existing services, and invest US$ 8 million, of which at least half must come from the company's own funds. Furthermore, 80% or more of the company's turnover must be generated by the activities qualifying for the relief, and assets must be acquired and the proposed activities (production or provision of services) must begin within three years after approval of the incentive. If the activity is carried out in a region where unemployment exceeds 10%, the minimum investment requirement will be halved.

Qualified taxpayers will receive a 100% tax credit for a full ten years. In addition, they are eligible for a grant from the Government of Slovakia to retrain employees and create new jobs. The government will provide no more than US$ 200 per employee for retraining, provided the employee continues to work for the employer for no less than 12 months after the completion of the retraining. The amount of the grant for new job creation will be determined by special regulation, and it will be available when the employer can verify that the new employee has been employed for at least 300 calendar days.

Slovak Investment and Trade Development Agency (SARIO)

SARIO is a full service investment promotion agency which addresses the needs of foreign investors and helps Slovak enterprises identify suitable foreign partners.

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821 02 Bratislava
Tel: +421 7 4342 1851 (and 52)
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Email: sario@sario.sk
Web site: http://www.sario.sk/

No Specific Law for Geothermal

Slovakia has no specific geothermal legislation. Geothermal resources are state property. There is no general procedure for developing geothermal resources. Guidelines exist for licensing geothermal exploitation; geothermal licensing is issued by the state; and geothermal is included in the national energy master plan.

The Government of Slovakia supports investment in geothermal projects through tax incentives and free utilization of existing wells.

Geothermal Sites / Projects

Northern Slovakia is dominated by the Carpathian Mountains which include the High Tatra range, the Low Tatras, and the Slovak Ore (Slovenske) Mountains. Lowlands are located in the southern part of the country. The Danube River forms Slovakia's southern border with Hungary.

Slovakia has considerable low, medium, and high enthalpy geothermal resources. Geothermal resources are found under the Danube plain near Bratislava in aquiverous layers of sand and limestone and in limestone layers in the easternmost part of the country; and in the Tatra Mountains in the north. The central depression of the Danube Basin is the best investigated geothermal area in the Slovak Republic.

Temperatures and heat flow densities of geothermal fields are highly variable. At a depth of 1000 m, temperatures range from 20°C in the Komarno high block, to more than 70°C in the Eastern Slovak basin (KAPA Systems and the European Geothermal Energy Council, 1999).

The geothermal gradient in the Inner West Carpathians averages 37°C/km; heat flow density varies from 50mW/m^2 in the Vienna basin to 120mW/m^2 in the Eastern Slovak basin. The highest temperatures, geothermal gradient, and heat flow density indicate that the Eastern Slovak basin is the most active region in the country.

Although thermal springs were known as early as the Middle Ages, the first well was drilled in Slovakia in 1879 in Ganovce. The second geothermal well was drilled in 1899 in Kovacova.

A century later, in the 1970s and '80s, the Dionyz Institute of Geology[8] identified 26 prospective areas and structures with potentially exploitable geothermal energy resources have been defined across the country. These aquifers lie at depths of 200-5000 m (excluding thermal springs) and have reservoir temperatures of 20-240ºC (Fendek and Franko, 2000). Drilling has been done in 14 of the 26 areas.

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8 The Geological Survey of the Slovak Republic (formerly the Dionyz Stur Institute of Geology) summarized the knowledge of geothermal resouces in Slovakia in The Atlas of Geothermal Energy of Slovakia (Franko, et al., 1995).

From 1971-1994, 61 geothermal wells were drilled (only 4 of them were unsuccessful), encountering 900 l/s of water at 20-92ºC.

In 1996, the Ministries of the Environment and Economy outlined the "Conceptual Proposal of Geothermal Energy of the Slovak Republic" which the Government accepted as a Resolution. In this Resolution, the Government obliged the Ministry of Environment to evaluate the utilization of geothermal energy in the Central Depression of the Danube Basin, Poprad Basin, Liptov Basin, and the Skorusina Depression; to prepare the hydrogeothermal evaluation of the Ziar Basin; and to study the possibilities of implementing a Hot Dry Rock program in the country.

The main challenges to the future development of geothermal energy are:

- Cleaning or re-injection of waters into the wells is too costly for farms which are potential users of this energy;

- Utilization of geothermal energy in district heating systems is blocked by lack of interest at the community level; and

- Industry which could use the energy for process heat or other heating purposes is not interested in projects with long payback periods (Bedi, 1996).

Slovakia has an installed capacity of 132.3 MWt producing 2,118 TJ/yr of energy. Geothermal water is used for recreation (swimming pools, spa), agriculture (greenhouses heating, fishery) and district heating. Total utilization is 588 GWh/yr; the capacity factor is 51%. To date, 95 person-years and US$ 11.75 million have been invested in geothermal development in the country (Lund and Freeston, 2000).

Slovakia has 162.5 MWt of proven resources, 69.5 MWt of predicted resources, and 321.0 MWt of probable resources. In reserves, the country has 116.2 MWt of proven reserves, 357.8 MWt of predicted reserves, and 4,511 MWt of probable reserves. The country's total thermal energy potential from geothermal waters is 5,538 MWt (Fendek, 2001).

Geothermal energy contributes 4.9% of the country's total renewable energy's energy generation for heat. It could contribute 22.6% of the total heat and 0.6% of electricity, or 60 GWh/yr.

Slovakia has no electricity generated from geothermal resources but plans to have 4 MWe installed capacity by 2005. The most promising geothermal area for power generation is the Kosice basin, where water temperatures of 115-165ºC at 2500-3000 m have a potential power generation potential of 25-30 MWe.

The Geothermal Energy Association did not estimate the country's potential power generation potential. A conservative estimate is 25-30 MWe.

The **Database of Geothermal Resources in Eastern Europe** contains information on 55 specific geothermal sites or projects in Slovakia. See Table 5 for a complete listing of the sites, their development status, temperature (ºC), and electric power generation potential. A complete description of each site, to the extent information is available, is included in the Appendix.

Slovakia's highest enthalpy geothermal resource identified to date is Kosice with a temperature of 165ºC. The average temperature of all sites is 37.4ºC. Two sites have a temperature of 100ºC or more.

Site/Project Name	Status	Temperature (ºC)
Banovce n/Bebravou	Direct use -- developed	40-55
Besenova	Direct use -- developed	30-62
Bojnice	Direct use -- developed	45
Calovo	Direct use -- developed	57-75
Central depression	Well(s) or hole(s) drilled	23-92
Chalmova	Direct use -- developed	39
Cilizska Radvan	Direct use -- developed	64-82

Site/Project Name	Status	Temperature (ºC)
Diakovce	Direct use -- developed	63-68
Dubnik depression	Well(s) or hole(s) drilled	52-75
Dunajska Streda	Direct use -- developed	55-91
Dunajsky Klatov	Direct use -- developed	74
Durkov	Well(s) or hole(s) drilled	115-150
Gabcikovo	Direct use -- developed	52
Galanta	Direct use -- developed	40-91
Ganovce	Well(s) or hole(s) drilled	24
Handlova	Preliminary identification/report	22-39
Hlohovec	Preliminary identification/report	24
Horna Nitra Basin	Direct use -- developed	45
Horna Poton	Direct use -- developed	66-68
Komarno	Well(s) or hole(s) drilled	20-56
Komjatice depression	Well(s) or hole(s) drilled	78
Kosice	Feasibility study	115-165
Kovacova	Direct use -- developed	40
Kralova pri Senci	Direct use -- developed	52
Levice	Direct use -- developed	26
Lipovce	Direct use -- developed	—
Liptov basin	Feasibility study	32-62

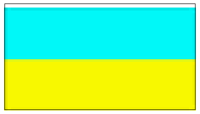
Site/Project Name	Status	Temperature (ºC)
Nove Zamky	Direct use -- developed	58-59
Oravice	Direct use -- developed	56
Partizanske	Preliminary identification/report	40
Pezinok	Direct use -- developed	—

Site/Project Name	Status	Temperature (ºC)
Piestany	Direct use -- developed	69
Podhajska	Direct use -- developed	80-82
Poprad	Direct use -- developed	—
Rajecke Teplice	Direct use -- developed	—
Rudno	Direct use -- developed	—
Ruzomberok	Preliminary identification/report	22
Sala	Direct use -- developed	42
Sklene Teplice	Direct use -- developed	—
Skorusina	Feasibility study	—
Sliac	Direct use -- developed	33
Sturovo	Direct use -- developed	23-40
Svaty Jur	Direct use -- developed	—
Topolniky	Direct use -- developed	74
Topolovec	Direct use -- developed	61
Trencianske Teplice	Direct use -- developed	—
Turcianske Terplice	Direct use -- developed	22-45
Tvrdosovce	Direct use -- developed	70
Upper Nitra basin	Well(s) or hole(s) drilled	66
Vienna basin	Well(s) or hole(s) drilled	73-78
Vlcany	Direct use -- developed	58-68

Site/Project Name	Status	Temperature (ºC)
Vrbov	Direct use -- developed	55-59
Vyhne	Direct use -- developed	—
Ziar nad Hronom	Well(s) or hole(s) drilled	90-95
Zvolen	Preliminary identification/report	—

Table 5 – Geothermal Resources in Slovakia


Slovakia
POLAND
CZECH REPUBLIC
AUSTRIA
HUNGARY
UKRAINE
ROMANIA
CROATIA
ZÁPADOSLOVENSKÝ
STREDOSLOVENSKÝ
VÝCHODOSLOVENSKÝ
BRATISLAVA
Bratislava
Vienna
Budapest
Częstochowa
Opole
Bytom
Katowice
Gliwice
Kraków
Tarnów
Rzeszów
Stalowa Wola
Przemyśl
Krosno
Nowy Sącz
Ostrava
Bielsko-Biała
Olomouc
Zlín
Brno
Zakopane
Žilina
Považská Bystrica
Martin
Liptovský Mikuláš
Poprad
Spišská Nová Ves
Bardejov
Prešov
Humenné
Michalovce
Košice
Uzhhorod
Chop
Rožňava
Trenčín
Prievidza
Banská Bystrica
Zvolen
Lučenec
Trnava
Nitra
Levice
Nové Zámky
Gabčíkovo Dam
Komárno
Győr
Sopron
Miskolc
Eger
Nyíregyháza
Szombathely
Székesfehérvár
Szolnok
Kecskemét
Zalaegerszeg
Kaposvár
Szeged
Neusiedler See
Balaton
Danube
Vistula
Oder
Morava
Váh
Hron
Hornád
Slaná
Ipeľ
Sajó
Tisza
Rába
Zala
Sió
Dunajec
San
Dnister
Svratka
International boundary
Department boundary
National capital
Department capital
Railroad
Road
Bratislava is the capital of both Bratislava and Západoslovenský Departments.
0 25 50 75 Kilometers
0 25 50 75 Miles
Lambert Conformal Conic Projection, SP 40N/56N
Base 802220 (R01166) 2-94



Ukraine

Power Profile

Population (millions) -July 2000 estimated	48.76
GDP (billion US$) - 2000 estimated	189.4
Real GDP Growth Rate - 2001 estimated	5.6%
Inflation Rate (CPI) - 2000 estimated	25.8%
Total Installed Capacity (MWe) - January 2000	51,900
Electricity Consumption per Capita (kWh) - 2000	2,772
Energy Demand Growth Rate	N/A
Prices (US¢/kWh) – 2001 Households Average wholesale Average industrial Average non-industrial commercial Source: Ukraine Energy Guide, USDOC	 1.8-2.7 2.2 3.4 4.3
Geothermal Power Potential (MWe)	1,000
Geothermal Direct Use Potential (MWt)	17,000

Ukraine is the second largest country in Europe, after Russia. Slightly smaller than Texas, Ukraine borders Belarus, Hungary, Moldova, Poland, Romania, Slovakia, Russia, and the Black Sea.

Richly endowed in natural resources, Ukraine has been in the crossfire and under foreign rule for centuries. A short-lived independence from Russia (1917-1920) was followed by brutal Soviet rule that engineered two artificial famines (1921-22 and 1932-33) in which over 8 million died. World War II resulted in an additional 7 million more deaths. Ukraine declared its independence from the Soviet Union on 24 August 1991.

In the decade since independence, Ukraine's progress toward a free market-based economy has been slow and fraught with backslides. One of the most serious was Ukraine's defaulting on its sovereign debt in 1998 as a result of the financial crisis in Russia. The country rescheduled its debt in 2001.

After posting eight consecutive years of negative real GDP growth rates, however, Ukraine appears to be turning the corner. For the first time since independence, the Ukrainian economy grew in the year 2000.

In 2001, the Ukrainian economy kept up its stunning rates of growth in the first eight months of 2001, expanding by 10.8%. Although growth has come from a relatively low base, the best crop harvest since 1991 and booming domestic demand helped to support equally impressive gains in exports, industrial output, and construction, resulting in an overall impressive performance (PlanEcon, 2001).

PlanEcon economists observe: The rapid pace of growth in the Ukrainian economy is a result of a rebound following years of collapsing output, and accommodating external conditions, in particular strong growth in Russia. However, the breadth of the current recovery is truly astonishing. It stretches across most branches of industry, construction, agriculture and market services. In fact, should the Ukrainian government show more commitment toward industrial restructuring and privatization, one could assume that the conditions are currently in place to ensure sustainable economic expansion for years to come.

In a major success for Prime Minister Anatoly Kinakh, after six months of negotiations, on 20 September 2001, the IMF decided to resume financing under its Extended Fund Facility. Ukraine received the first tranche of US$ 375 million in late September and is expected to receive another before the end of the year. Encouraged by the resumption of financing to Ukraine by the IMF, the World Bank also released US$ 150 million under a US$ 250 million First Programmatic Adjustment Loan.

Problems remain however. The shadow economy remains large, with many observers estimating that it is as large if not larger than the "official" economy. Privatization has proceeded unevenly with relatively rapid results in small-scale privatization and a slower pace for large-scale privatization.

Integration into the European Union is one of Ukraine's key foreign policy priorities. Ukraine is negotiating to join the World Trade Organization. The country's large eastern neighbor, however, remains an overwhelming factor in Ukraine's domestic and foreign policies.

Power Summary

Ukraine has a total installed capacity of 51,900 MWe. Almost half of the electricity is generated by fossil-fuel plants, about 45% by nuclear plants, and the remainder by hydropower plants. Ukraine has 19 power plants with a generating capacity of more than 1,000 MWe, 80% of which are 30 years or older and in dire need of modernization.

Ukraine is heavily dependent on Russia for oil and natural gas. Ukraine currently imports nearly 80% of its oil, almost all of which comes from Russia. Ukraine owes Russia US$ 1.97 billion dollars for natural gas, about 19.2% of its total foreign debt. In an effort to reduce its traditional dependence on Russian gas, Ukraine has signed several gas import deals with Turkmenistan.

With a highly developed oil pipeline system, Ukraine plays an important role as a transit country for Russian oil exports to Europe. The southern branch of the 1.2-million-bbl/day Druzhba pipeline from Russia crosses

Ukraine en route to Slovakia, Hungary, and western Europe. In addition, due to its geographic location and its oil pipeline system, Ukraine has an excellent opportunity to play a major role in bringing increased oil exports from Azerbaijan and Kazakhstan to European oil markets. Rather than seeking to import Caspian Sea region oil for domestic consumption, Ukraine is hoping to reap tariffs for Caspian oil crossing its territory as it heads westwards.

Ukraine currently operates four NPPs with 13 reactors and a total capacity of 11.8 GW. Ukraine's nuclear power plants produce 40% of the country's power output, despite frequent malfunctions plus lengthy repairs and maintenance.

Ukraine permanently shut down the last remaining working reactor at Chernobyl NPP on 15 December 2000. To make up for the power shortfall from Chernobyl's closure, the country resumed construction of two 1-GW reactors at the Khmelnitsky and Rivne NPPs. A US$ 1.5 billion Western project to help Ukraine complete the two reactors collapsed on 29 November. President Leonid Kuchma said that the Western conditions mean "eternal slavery for Ukraine," and proposed that Russia take part in the completion of the two reactors "on any conditions [Russia likes]" (Interfax via RFE/RL).

In an effort to diversify its energy sector, the Government of Ukraine is promoting nontraditional sources of energy and alternative fuels. It has three programs in place to encourage the use of renewable energy:

1. Wind power engineering development program,[9]

2. The "Ecologically clean geothermal power engineering of Ukraine" Program, and

3. The state-supported Program to develop renewable energy resources including small hydro and heat power engineering.

Although the government considers renewables as a prospective sub-sector, development is hampered by limited financial resources.

Due to years of recession, energy demand has fallen sharply; no new capacity is estimated to be required until 2010 (Ryding, 1998). Despite this, power shortages are not uncommon due to Ukraine's dependence on imported fuel.

In September, the country's national regulatory body declared a state of emergency in the energy sector due to the low stockpile in coal and mazute for winter fuel reserve.

[9] The government of Ukraine considers the development of the wind power industry as a top priority, and anticipates having 1,980 MW of installed wind capacity by 2010. There are currently over 150 wind power units operating in the country.

Government / Legislation

Ukraine began reforming the electrical power industry in November 1994 with the establishment of an independent regulator.

Ukrainian legislation provides that thermal power generation companies and regional power distribution companies (oblenergos) must be privatized. Six electricity distribution companies were privatized in April 2001 bringing in US$ 160 million–much less than anticipated. Tenders for the further privatization of energy enterprises will be issued in the beginning of 2002. The following state-owned properties will not be privatized:

- Nuclear power plants (NPPs), operating hydro power stations (HPSs), and combined heat and power plants (CHPPs):
- Regional electric grids with a voltage of 220 kV and higher,
- Dispatching system of dispatcher and technological control of the united electric power system; and
- Some major scientific research projects.

Ukrainian legislation allows construction of HPSs and CHPPs by IPPs.

National Electricity Regulatory Committee (NERC)

Created in December 1994, NERC was established to monitor the power market. It issues and monitors licenses for electricity generation, high voltage transmission, low voltage distribution, and tariff and non-tariff supply. In addition, NERC promotes competition, protects consumers, oversees the operation of the electricity market, regulates prices for high- and low-voltage network operators, and sets margins for tariff suppliers.

According to NERC and antimonopoly legislation, a single company cannot own more than 15% of Ukraine's power supply capacity.

Energomarket (Energorynok)

The wholesale electricity market, is administered by the National Dispatch Centre (NDC) which has the following responsibilities *inter alia*: to purchase and dispatch power capacity and electricity and to administer settlements systems (including the administration of market funds). Technical and financial market operations are governed by a set of Market Rules described in the Energomarket Members Agreement (EMA). The wholesale market began operating 10 April 1996.

The actors in the electricity market are:

- Competing electricity generation companies and independent small power producers;
- National Dispatching Center (NDC) as a wholesale market regulator;
- Numerous buyers, primarily 27 joint-stock electricity distribution companies in all regions of Ukraine;
- State energy transmission company; and
- NERC.

According to the current electricity market model, all electricity produced by generation companies is sold to Energorynok. From there it is purchased by electricity distribution companies and sold to customers. Since currently customers do not ensure timely and full payment for the purchased energy, the uniform distribution account in the market was created under a governmental decree, in which energy distribution companies should transfer all money obtained from customers. The funds, collected in the distribution account are distributed between electricity distribution companies, transport, and generation companies under the algorithm authorized by the NERC.

Based on the UK power pool model, Energorynok determines the dispatch of all electricity generators according to their bids, subject to certain constraints. Payments for all electricity delivered to consumers flow through a gross pool (Lovei, 1998).[10]

The electricity market has not worked on a free market basis. In late 1996, NERC was (informally) instructed by the Cabinet to leave retail prices unchanged until further notice. The proliferation of barter and other noncash payment modes, e.g., mutual cancellation of payment obligations, promissory notes, and tax write-offs, further compromised application of the market rules. At its height, the share of noncash transactions in the power industry surpassed 80%.

National Power Energy Program to 2010

Adopted in May 1996, the National Power Energy Program has three principal priorities: the use of indigenous primary energy resources, development of non-conventional and renewable sources of energy, and energy saving.

The operation of the Ukrainian energy sector is framed by a number of laws, decrees of the President of Ukraine, orders etc. The basic laws that regulate the activity in energy sector are:

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[10] The alternative option, a "net," or residual, pool, accepts bilateral contracts as a basis for generator dispatch, and the bidding process is applied only to the generation of electricity needed to satisfy demand not covered by these contracts.

- Law on Electric Power Industry,
- Law on Energy Saving,
- Law on Concessions,
- Code on Entrails,
- Mountain Law,
- Decree of the President of Ukraine on the National Commission of Energy Regulation,
- Decree of the President of Ukraine on the basic directions of investment policy for 1999-2001, and
- Decree of the President of Ukraine on some issues related to the privatization of assets of electric power industry.

Law on the Electric Power Industry (No. 575-10/97, amended June 2000)

This Law determines the legal, economic, and institutional principles in the power industry and regulates relationships arising from or in conjunction with the generation, transmission, supply, and usage of electricity, providing for Ukraine's energy safety, competition, and protecting the rights of consumers and workers of the industry.

According to the Law, electrical and thermal energy are considered commodities. In addition, the Electricity Law states that NERC is to be an independent State agency that is to be funded from license fees that it collects for issuing licenses to the entities that it regulates.

Law on Concessions

Based on concession agreements, the right to develop natural resources using state property can be granted to foreign investors. The duration of concession agreements is determined by concession terms, but cannot exceed 99 years.

Law on Ownership

The Constitution of Ukraine guarantees the right to private ownership, including the right to own land. In addition, Ukraine's Law on Ownership specifically recognizes private ownership and includes Ukrainian residents, foreign individuals, and foreign legal entities among those entities able to won property in Ukraine. Moreover, the law permits owners of property (including foreign investors and joint ventures) to use such property for commercial purposes, to lease property, and to keep the revenues, profits and production derived from its use.

The Law on Ownership does not, however, establish a comprehensive regime regulating the rights of ownership and the mechanisms for their transfer. Some difficulties have arisen over foreign acquisition of majority control of enterprises, with the Government or the current management continuing to exercise effective control or veto power over company decisions.

While private ownership of land is permitted by the Constitution, a land code laying out completely the legal foundations of private property and well as the foundations of a market for land has yet to be passed (Country Commercial Guide, 2001).

Land Code

The current Land Code of Ukraine, adopted in 1992, regulates the ownership, use, and disposition of rights and interests in land. The Code was adopted four years before the Constitution and is inconsistent with it in some of its provisions. The right to own land is still subject to substantial limitations. A new Land Code is being developed, and the draft allows foreign ownership of land for non-agricultural purposes. In addition to the proposed new Code, there are several presidential decrees that permit foreign ownership of enterprise land. The new Land Code would strengthen the legislative framework for foreign ownership.

According to the Land Code of Ukraine, foreign investors may receive land, which is state property, from local Soviets. Foreign legal entities and persons, joint ventures, international organizations can rent land either on short term (up to 3 years) or on long-term (up to 50 years), with further possible prolongation for the same period.

In June 1999, President Kuchma issued a decree permitting mortgages on land and buildings, both private and commercial. However, banks are reticent to provide financial backing for the purchase of real or personal property.

Tariffs

Ukraine's Cabinet of Ministers ordered NERC and a number of ministries in October to develop a schedule for gradually increasing residential electricity rates during 2001-2004. Under the directive, during 2001-2002, the Government would develop a legislative base to replace existing practices of directly subsidizing certain privileged electricity consumers. The Government would also identify sources for payment of these subsidies.

The Ministry of Economy supports increasing tariffs for residential consumers by 10% in 2001 and another 10% in 2002. The ministry states that tariffs may have to be increased by 60% in some oblasts.

In the beginning of 2001 the Government promised investors to increase tariffs for privatized power distribution companies to provide for their profitability. According to NERC, electricity tariffs paid by the population cover only 80% of its real cost.

Currently, the retail price for households is 1.8-2.7¢/kWh (less in rural and more in city areas), the average wholesale tariff is 2.2¢/kWh, and the average industrial tariff is 3.4¢/kWh. Analysts predict that by the end of 2002 the tariffs may increase to 3¢/kWh.

Foreign Investment

All branches of the energy sector are open for foreign investment.

Over the past seven years, Ukraine has received a mere US$ 3.9 billion in FDI, the second lowest amount in any of the 15 former Soviet Union Republics except for Belarus. Ukraine's complex and contradictory tax system, overall high tax rates, changing and unpredictable legislation, and corruption are major deterrents to investment.

Recognizing the need for the government to create a favorable investment and private business climate in Ukraine, in June Prime Minister Kinakh announced an immediate plan of action to accelerate investment activity.

<u>Law on Foreign Investment (April 1996)</u>

The law guarantees foreign investors equal treatment with local companies and provides potential privileges. It permits exemption from customs duties for in-kind contributions of fixed assets imported into Ukraine from a company's charter fund. The law also provides general guarantees against expropriation, unhindered transfer of profits and post-tax revenues, and a ten-year guarantee against changes in legislation that affect these basic protections.

<u>Republic of Crimea Foreign Investment</u>

As of 1 January 2000, Ukrainian legislation grants the following privileges to foreign investors operating in Crimea:

1. No income tax for the first 3 years; 50% of current income tax rate for years 4-6;

2. A five-year exemption from customs duty for imports intended as part of a foreign direct investment project;

3. No land payment during land development period for 5 years; and

4. No fee to the state innovation fund for the period of realization of investment project up to 5 years.

Privileges are further granted on a sliding scale based on the amount of foreign investment, ranging from US$ 100,000 to US$ 1 million, and on industry sector.

<u>No Specific Law for Geothermal</u>

Ukraine has no specific geothermal legislation. Geothermal licensing is issued by the state. While the Government of Ukraine supports the "Ecologically clean geothermal power engineering of Ukraine" Program, a major obstacle for commercializing geothermal energy in

Ukraine is the lack of domestic investment. Financing is available from international sources.

The Danish company House and Olsen assessed geothermal resources and the economic feasibility of heating projects in Ukraine at Beregovo, Krasnogvardeisk, and Yantarne. As a follow-on, the Government of Denmark will release US$ 150 million to Ukraine to build the first geothermal power plant in Crimea. The plant will be commissioned in September 2002. The Institute of Technical Thermal Physics of the National Academy of Sciences of Ukraine will manage the research.

Geothermal Sites / Projects

Ukraine is primarily covered by flat plains or gently rolling hills. The only mountain ranges are the Carpathians in the far west and the Yayla Range in the southern part of the Republic of Crimea.

More than 40% of Ukraine's territory contains promising geothermal sites, primarily in the mountainous areas in the west and the Republic of Crimea (Dolinsky et al., 2001). The country has three primary geothermal regions:

1. The Zakarpatsky Basin in the Trans-Carpatian Trough. Artesian wells produce 60-90°C thermal waters from reservoirs located between 1000-2500 m depth (Beregove, Uzhgorod, Kosyno, Tereblju). A deep well (Zaluzska-3, 4050 m) produces 210°C hot waters.

2. The Kharkiv-Poltava Region in the Dnepr-Donec Basin. More than 100 wells with depth between 3000 to 4500 m. have been drilled. Measured water temperatures range from 125 to 168°C.

3. The Republic of Crimea. Maximum temperatures of 158°C have been measured in wells up to a depth of 2400 m.

Low enthalpy geothermal resources (60-90°C) are used in the Republic of Crimea mainly for space heating. Five geothermal systems are operating with a total installed capacity of 12 MWt. A 1.5-MWt geothermal station began operating in Zakarpattya in 1999. Total heat potential estimates range from 17,000 MWt (Dolinsky et al., 2001) to more than 50,000 MWt, according to the Committee for Geology and Use of Mineral Resources (Shurchkov et al., 2000).

Ukraine has no electricity generated from geothermal resources. The Danish government is supporting the development of the country's first geothermal power plant in Crimea. In addition, two pilot geothermal binary power stations with a capacity of 1.5 MWe each are planned for construction by 2005 (KAPA Systems). Ukraine's total geothermal power potential is estimated at 1,000 MWe (Dolinsky et al., 2001).

The **Database of Geothermal Resources in Eastern Europe** contains information on 28 specific geothermal sites or projects in Ukraine. See Table 6 for a complete listing of the sites, their development status, temperature (ºC), and electric power generation potential. A complete description of each site, to the extent information is available, is included in the Appendix.

Ukraine's highest enthalpy geothermal resource identified to date is Zaluzska with a temperature of 210ºC. The average temperature of all sites in Ukraine is 59.8ºC. Thirteen sites have a temperature of 100ºC or more.

Site/Project Name	Status	Temperature (ºC)
Beregovo	Feasibility study	70
Glibivska	Well(s) or hole(s) drilled	127
Gorobtsivska	Well(s) or hole(s) drilled	146
Ilyinka	Direct use -- developed	57
Irshava	Well(s) or hole(s) drilled	—
Izjum	Well(s) or hole(s) drilled	198
Kerchensky	Well(s) or hole(s) drilled	200
Kotelnikovo	Direct use -- developed	65
Krasnogvardeisk	Feasibility study	91
Medvedevka	Direct use -- developed	67
Mostyska	Well(s) or hole(s) drilled	128
Nizinnoye	Direct use -- developed	47
Novo-Alekseyevka	Direct use -- developed	54
Novomechebylivska	Well(s) or hole(s) drilled	152
Oktjabrska	Well(s) or hole(s) drilled	158
Pyatihatki	Direct use -- developed	51

Site/Project Name	Status	Temperature (ºC)
Rovnoye	Direct use -- developed	62
Severo-Sivashkoe	Well(s) or hole(s) drilled	52-74
Shevchenkivska	Well(s) or hole(s) drilled	168
Sizovka	Direct use -- developed	61
Spivakovsky	Well(s) or hole(s) drilled	174
Tarkhancutsky	Well(s) or hole(s) drilled	200
Tereblia	Well(s) or hole(s) drilled	95-105
Trudovoye	Direct use -- developed	53
Uzhgorod	Well(s) or hole(s) drilled	108
Yantarne	Direct use -- developed	85
Zaluzska	Well(s) or hole(s) drilled	210
Zernovoye	Direct use -- developed	50

Table 6 – Geothermal Resources in Ukraine

Base 802140 (R00339) 4-93

Conclusion

Bulgaria, the Czech Republic, Romania, Slovakia, and Ukraine, as individual countries as well as components of the greater strategically important Southeastern European region, are receiving large amounts of foreign assistance from the European Community, the United States, the World Bank, and others.

From 2000-02, the five countries will receive over US$ 4 billion in technical assistance from the EU. The U.S. Government is putting roughly US$ 1.2 billion in foreign assistance into the region in FY 2001.

In addition to multilateral assistance, many of the countries receive bilateral assistance. Denmark is a prominent donor in the area of geothermal energy.

From April to November 2001, the Danish Ministry of Environment and Energy on Geothermal Systems conducted a strategic assessment of the technical, economic, and environmental potential in Central and Eastern Europe (CEE), Ukraine, and Russia. The effort is part of the Denmark's Danish Cooperation for Environment in Eastern Europe (DANCEE) program which provides environmental assistance to the region. In 2001, the DANCEE budget was US$ 80 million.

DANCEE has initiated and co-funded six geothermal energy projects in CEE, investing more than US$ 9 million. This includes two projects in Slovakia (US$ 1.5 million), one project in the Czech Republic (US$ 1.1 million), and feasibility studies in Romania (US$ 85,000) and Ukraine (US$ 75,000).

With the influx of foreign assistance, and the European Parliament's July 2001 approval of a law that would double the percent of the EU's energy consumption from renewables to 12% by 2010, significant impetus exists to the future development of geothermal direct use and power projects in the region.

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Appendix

Bulgaria

Site/Project Name	***Aitos***
Location	In the east-central part of the country; 42º40' latitude, 27º13' longitude; in Bourgas region
Status	Feasibility study
Temperature (ºC) from	19
Temperature (ºC) to	52
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 20-30 dm3/s (Peneve and Shterev, 2000). Estimated reservoir temperature is 52ºC (Bojadgieva et al., 1995).

Site/Project Name	***Al. Voikov***
Location	42º47' latitude, 23º28' longitude
Status	Feasibility study
Temperature (ºC) from	43
Temperature (ºC) to	56
Installed capacity (MWe)	0
Potential (MWe)	0

Bulgaria

Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Estimated reservoir temperature is 56ºC (Bojadgieva et al., 1995).

Site/Project Name	***Albena***
Location	In northeastern Bulgaria; in Varna region
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	28
Temperature (ºC) to	30
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1992 - Production, artesian well drilled to 1409m. Flow rate of 20 kg/s; wellhead pressure of 1.75 bar (Bojadgieva et al., 1995).
Notes	The flow rate is 100-150 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Assenovgrad***
Location	In Plovdiv region
Status	Preliminary identification/repo

Bulgaria

Temperature (ºC) from	26
Temperature (ºC) to	36
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Geothermal resource includes Assenovgrad north and south.

Site/Project Name	***Bachevo***
Location	41º56' latitude, 23º26' longitude
Status	Feasibility study
Temperature (ºC) from	26
Temperature (ºC) to	46
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Estimated reservoir temperature is 46ºC (Bojadgieva et al., 1995).

Bulgaria

Site/Project Name	***Badino***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	19
Temperature (ºC) to	50
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	3.66
Chronology	
Notes	Measured temperature is 19ºC; estimated temperature is 50ºC; estimated thermal power is 3.66 MWt (Shterev et al., 1995).

Site/Project Name	***Balchik***
Location	In Varna region
Status	Preliminary identification/repo
Temperature (ºC) from	24
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Banevo***
Location	In Bourgas region
Status	Preliminary identification/repo
Temperature (ºC) from	24
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Bankia***
Location	43º43' latitude, 23º09' longitude
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	42

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.26
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology and space heating. Flow rate is 35.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 42ºC (Bojadgieva et al., 1995).

Site/Project Name	***Banya***
Location	In Plovdiv region
Status	Preliminary identification/repo
Temperature (ºC) from	28
Temperature (ºC) to	58
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 70.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Bulgaria

Site/Project Name	***Banya Karlovo***
Location	42º33' latitude, 24º50' longitude
Status	Direct use -- developed
Temperature (ºC) from	35
Temperature (ºC) to	54
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.4
Potential (MWt)	2.9
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for space heating, balneology, and greenhouses. Flow rate is 28.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Banya Panagiursko***
Location	42º28' latitude, 24º08' longitude
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	43
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Flow rate is 22.0 l/s; Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Banya-Korten***
Location	42º36' latitude, 26º00' longitude
Status	Direct use -- developed
Temperature (ºC) from	42
Temperature (ºC) to	86
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Flow rate is 7.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 86ºC (Bojadgieva et al., 1995).

Bulgaria

Site/Project Name	***Banya-Plovdiv***
Location	In central Bulgaria
Status	Direct use -- developed
Temperature (ºC) from	46
Temperature (ºC) to	50
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. The flow rate is 35-40 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Banya-Razlog***
Location	In the southwestern part of the country
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the “Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets” project.
Notes	The geothermal resource is used for balneology for a 18th-century Turkish bath and a swimming pool. The mineral water is very oily.

Site/Project Name	***Barzia***
Location	43º17' latitude, 23º07' longitude
Status	Direct use -- developed
Temperature (ºC) from	31
Temperature (ºC) to	66
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Bulgaria

Site/Project Name	***Batchevo***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	21
Temperature (ºC) to	26
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 10.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Bedenski Bani***
Location	In the south-central part of the country; 41º42' latitude, 24º30' longitude; in Plovdiv region
Status	Direct use -- developed
Temperature (ºC) from	73
Temperature (ºC) to	76
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Flow rate is 10.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Belchin Banya***
Location	42º22' latitude, 23º28' longitude; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	41
Temperature (ºC) to	42
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Flow rate is 16.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Belovo***
Location	42º12' latitude, 24º03' longitude; in Plovdiv region

Bulgaria

Status	Feasibility study
Temperature (ºC) from	20
Temperature (ºC) to	25
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 85.0 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Biala voda***
Location	In Sofia region
Status	Preliminary identification/repo
Temperature (ºC) from	27
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	

Bulgaria

Notes

Site/Project Name	***Birimirtzi***
Location	43º43' latitude, 23º25' longitude
Status	Feasibility study
Temperature (ºC) from	30
Temperature (ºC) to	65
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Estimated reservoir temperature is 65ºC (Bojadgieva et al., 1995).

Site/Project Name	***Blagoevgrad***
Location	On the Struma River in southwestern Bulgaria; 42º02' latitude, 23º06' longitude; in the Struma (Strymon) rift valley; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	55
Temperature (ºC) to	100
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	5.75
Chronology	
Notes	The geothermal resource is used for greenhouses, and includes Blagoevgrad 1 and 2. Flow rate is 10.0-16.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 100ºC (Bojadgieva et al., 1995). Measured temperature is 55ºC; estimated thermal power is 5.75 MWt (Shterev et al., 1995).

Site/Project Name	***Boaza-Turgovishte***
Location	In Rousse region
Status	Preliminary identification/repo
Temperature (ºC) from	26
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Bulgaria

Site/Project Name	***Bratzigovo***
Location	42º02' latitude, 24º22' longitude; in Plovdiv region
Status	Direct use -- developed
Temperature (ºC) from	18
Temperature (ºC) to	26
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 3.0 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Bresovo***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	21
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt) 0

Chronology 1994 - Exploration, artesian well drilled to 300m; wellhead pressure of 0.03 bar (Bojadgieva et al., 1995).

Notes

Site/Project Name ***Burgaski Bani***

Location In the east-central part of the country; 42º37' latitude, 27º24' longitude

Status Direct use -- developed

Temperature (ºC) from 20

Temperature (ºC) to 150

Installed capacity (MWe) 0

Potential (MWe) 0

Installed capacity (MWt) 0

Potential (MWt) 0

Chronology Roman times - The Bourgas mineral baths were popular.

17th to 19th century - The Bourgas basin was the subject of investigations of foreign specialists, e.g., Hadji Kalfa, Ami Boue, Hochsteffer, Irechec, and others.

Since 1933 - Investigations carried out.

Since 1954 - Numerous scientists conducted geological studies, geophysical survey, drilling and completion tests of wells, and geochemical exploration. Geological, hydrogeological, and geochemical studies have led to the identification of six hydrogeothermal fields and nine occurrences.

Bulgaria

Notes	The geothermal resource is used for balneology at the Bourgas Spas, and bottling of water. As a rule, the Bourgas hydrothermal basin has limited resources. Because of its special geological structure, the total dynamic resources of the thermal and sub-thermal waters is estimated at about 110 l/s. Exploitation is still on a very limited scale. At the moment about 54.4 l/s are being utilized, or 47% of the total flow available. The maximum predicted temperatures are 100-120ºC in the lower part of the Upper Cretaceous Complex, and 150ºC in the Triassic and Jurassic sediments. Temperatures ranging from 36-to 135ºC were found using the Na-K geothermometer (Giggenbach, 1988). The chemical composition of 30 geothermal wells in the Bourgas hydrothermal basin were interpreted using the WATCH program (Bjarnason, 1994), which gives information about the mineral equilibrium. The composition of the thermal and sub-thermal waters discovered is mostly bicarbonate-sodium, chloride-sodium, chloride-sulfate-sodium, and bicarbonate-sulfate-chloride-sodium.

Site/Project Name	***Burzhia***
Location	In Montana region
Status	Preliminary identification/repo
Temperature (ºC) from	33
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0

Bulgaria

Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Chaika***
Location	On the Black Sea
Status	Direct use -- developed
Temperature (ºC) from	25
Temperature (ºC) to	45
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for space heating, air conditioning, and balneology at the Chaika Resort.

Site/Project Name	***Chepino***
Location	41º59' latitude, 23º58' longitude; in Plovdiv region; in southwestern Bulgaria; in the Rhodope

	Mountains
Status	Direct use -- developed
Temperature (ºC) from	32
Temperature (ºC) to	48
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for space heating, balneology, and greenhouses. Flow rate is 70.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Surface temperatures range from 37-48ºC, pH from 9.27-9.45, and TDS from 196-204 mg/l (Veldeman et al., 1990).

Site/Project Name	***Chepintci***
Location	42º45' latitude, 23º32' longitude; in Sofia City
Status	Feasibility study
Temperature (ºC) from	51
Temperature (ºC) to	60
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Estimated reservoir temperature is 60ºC (Bojadgieva et al., 1995).

Site/Project Name	***Chifflik***
Location	In the north-central part of the country; in Lovech region
Status	Direct use -- developed
Temperature (ºC) from	39
Temperature (ºC) to	51
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.9
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for space heating, balneology, and greenhouses. The flow rate is 33-40 dm3/s (Peneve and Shterev, 2000).

Bulgaria

Site/Project Name	***Chuchuligovo***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	60
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	2.82
Chronology	
Notes	Estimated temperature is 60ºC; estimated thermal power is 2.82 MWt (Shterev et al., 1995).

Site/Project Name	***D. Bogrov***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	28
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt) 0

Chronology 1992 - Production, pumped well drilled to 250m; flow rate of 15 kg/s (Bojadgieva et al., 1995).

Notes

Site/Project Name	***D. Botevo***
Location	41º45' latitude, 25º43' longitude
Status	Prefeasibility study
Temperature (ºC) from	21
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 1.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Davidkovo***
Location	41º38' latitude, 24º59' longitude
Status	Prefeasibility study
Temperature (ºC) from	35
Temperature (ºC) to	44

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 3.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Delchevo***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	35
Temperature (ºC) to	80
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	4.08
Chronology	
Notes	Measured temperature is 35ºC; estimated temperature is 80ºC; estimated thermal power is 4.08 MWt (Shterev et al., 1995).

Site/Project Name	***Devin***

Bulgaria

Location	In the south-central part of the country; in Plovdiv region
Status	Preliminary identification/repo
Temperature (ºC) from	44
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 35-40 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Devnja***
Location	In northern Bulgaria
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	19
Temperature (ºC) to	21
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Bulgaria

Chronology	1991 - Three production, artesian wells drilled to 503-800m. Flow rates of 60-100 kg/s; wellhead pressures of 1.18-2.15 bar (Bojadgieva et al., 1995). 1992 - Production, artesian well drilled to 5240m. Flow rate of 20 kg/s; wellhead pressure of 2.54 bar (Bojadgieva et al., 1995).
Notes	

Site/Project Name	***Dobrinishte***
Location	41º49' latitude, 23º34' longitude; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	31
Temperature (ºC) to	79
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Flow rate is 50.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 79ºC (Bojadgieva et al., 1995).

Site/Project Name	***Dobroslabtzi***

Bulgaria

Location	In Sofia City
Status	Preliminary identification/repo
Temperature (ºC) from	42
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Dolna Banya***
Location	In the west-central part of the country; 42º18' latitude, 23º46' longitude; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	55
Temperature (ºC) to	65
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Bulgaria

Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for balneology. Flow rate is 25.0 l/s; Carbon and Sulphur (estimated) present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Dolna Gradeshnitsa***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	60
Temperature (ºC) to	80
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	5.43
Chronology	
Notes	Measured temperature is 60ºC; estimated temperature is 80ºC; estimated thermal power is 5.43 MWt (Shterev et al., 1995).

Site/Project Name	***Dolni Dubnik***
Location	In the north-central part of the country; in Lovech region
Status	Direct use -- developed

Bulgaria

Temperature (ºC) from	65
Temperature (ºC) to	68
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	8
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for space heating and greenhouses. The flow rate is 75-150 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Dolni Lukovit***
Location	In the north-central part of the country; in Lovech region
Status	Preliminary identification/repo
Temperature (ºC) from	70
Temperature (ºC) to	73
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	

Bulgaria

Notes	The flow rate is 35-50 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Dolni Rakovetz***
Location	43º28' latitude, 23º01' longitude; in Sofia region
Status	Preliminary identification/repo
Temperature (ºC) from	21
Temperature (ºC) to	36
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 20.0 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Dolno Ossenovo***
Location	In the Struma (Strymon) rift valley; in Sofia region
Status	Preliminary identification/repo
Temperature (ºC) from	56
Temperature (ºC) to	75
Installed capacity (MWe)	0
Potential (MWe)	0

Bulgaria

Installed capacity (MWt)	0
Potential (MWt)	3.76
Chronology	
Notes	Measured temperature is 59ºC; estimated temperature is 75ºC; estimated thermal power is 3.76 MWt (Shterev et al., 1995).

Site/Project Name	***Doupnitza***
Location	In the Struma (Strymon) rift valley; in Sofia region
Status	Preliminary identification/repo
Temperature (ºC) from	31
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	1.88
Chronology	
Notes	Measured temperature is 31ºC; estimated temperature is 60ºC; estimated thermal power is 1.88 MWt (Shterev et al., 1995).

Site/Project Name	***Draginovo***
Location	In southwestern Bulgaria; 42º03' latitude, 24º00' longitude; in Plovdiv region
Status	Direct use -- developed

Bulgaria

Temperature (ºC) from	59
Temperature (ºC) to	97
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2.5
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for greenhouses. Flow rate is 15.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Surface temperatures range from 12-94ºC, pH from 7.62-8.00, and TDS from 302-703 mg/l (Veldeman et al., 1990).

Site/Project Name	***Drouzhba ZK***
Location	43º17' latitude, 28º02' longitude; in Lovech region
Status	Direct use -- developed
Temperature (ºC) from	46
Temperature (ºC) to	69
Installed capacity (MWe)	0
Potential (MWe)	0

Bulgaria

Installed capacity (MWt)	20.8
Potential (MWt)	26.8
Chronology	
Notes	The geothermal resource is used for space heating and balneology.

Site/Project Name	***Dzhebel***
Location	In Haskovo region
Status	Preliminary identification/repo
Temperature (ºC) from	33
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Elenov dol***
Location	43º03' latitude, 23º28' longitude
Status	Preliminary identification/repo

Bulgaria

Temperature (ºC) from	19
Temperature (ºC) to	26
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 0.5 l/s; Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Eleshnitza***
Location	In southwestern Bulgaria; 41º52' latitude, 23º36' longitude; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	21
Temperature (ºC) to	56
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.9
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.

Bulgaria

Notes	The geothermal resource is used for balneology and greenhouses. Flow rate is 8.0-25.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Erma Reka***
Location	In the south-central part of the country; 41º22' latitude, 24º58' longitude
Status	Feasibility study
Temperature (ºC) from	87
Temperature (ºC) to	100
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is approximately 100 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Gnilane***
Location	42º46' latitude, 23º28' longitude
Status	Feasibility study
Temperature (ºC) from	42
Temperature (ºC) to	50
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Estimated reservoir temperature is 50ºC (Bojadgieva et al., 1995).

Site/Project Name	***Gorna Banya***
Location	43º41' latitude, 23º15' longitude
Status	Direct use -- developed
Temperature (ºC) from	16
Temperature (ºC) to	42
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Flow rate is 7.5 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Gorna Breznitza***

Bulgaria

Location	In the Struma (Strymon) rift valley; in Sofia region
Status	Preliminary identification/repo
Temperature (ºC) from	38
Temperature (ºC) to	55
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	2.51
Chronology	
Notes	Measured temperature is 40ºC; estimated temperature is 55ºC; estimated thermal power is 2.51 MWt (Shterev et al., 1995).

Site/Project Name	***Gorna Gradeshnitsa***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	67
Temperature (ºC) to	80
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	5.43

Bulgaria

Chronology	
Notes	Measured temperature is 67ºC; estimated temperature is 80ºC; estimated thermal power is 5.43 MWt (Shterev et al., 1995).

Site/Project Name	***Gotzedeltchevski Bani***
Location	41º37' latitude, 23º49' longitude
Status	Prefeasibility study
Temperature (ºC) from	25
Temperature (ºC) to	43
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 70.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Gradeshka Banya***
Location	41º42' latitude, 23º14' longitude
Status	Prefeasibility study
Temperature (ºC) from	45
Temperature (ºC) to	68

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 4.8 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Guliana Banya***
Location	In southwestern Bulgaria; 41º53' latitude, 23º32' longitude; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	41
Temperature (ºC) to	61
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	4
Potential (MWt)	10
Chronology	
Notes	The geothermal resource is used for balneology and greenhouses. The flow rate is 60-80 dm3/s (Peneve and Shterev, 2000). Estimated reservoir temperature is 61ºC (Bojadgieva et al., 1995).

Bulgaria

Site/Project Name	***Gurmen-Ognianovo***
Location	In southwestern Bulgaria; 41º37' latitude, 23º48' longitude; in Haskovo region
Status	Direct use -- developed
Temperature (ºC) from	35
Temperature (ºC) to	45
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for balneology. Flow rate is 40.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 45ºC (Bojadgieva et al., 1995).

Site/Project Name	***Harmanli***
Location	41º56' latitude, 25º54' longitude
Status	Prefeasibility study

Bulgaria

Temperature (ºC) from	13
Temperature (ºC) to	23
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 3.0 l/s; Sulphur and Chlorine present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Hisar***
Location	In central Bulgaria; 42º31' latitude, 24º43' longitude; in Plovdiv region
Status	Direct use -- developed
Temperature (ºC) from	23
Temperature (ºC) to	69
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.26
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology and space heating.

Flow rate is 42.6 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Estimated reservoir temperature is 69ºC (Bojadgieva et al., 1995).

Site/Project Name	***Hotovo***
Location	41º28' latitude, 23º21' longitude; in the Struma (Strymon) rift valley; in Sofia region
Status	Feasibility study
Temperature (ºC) from	37
Temperature (ºC) to	80
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	5.43
Chronology	
Notes	Measured temperature is 37ºC; estimated temperature is 80ºC; estimated thermal power is 5.43 MWt (Shterev et al., 1995).

Site/Project Name	***Hskovski Bani***
Location	In south-central Bulgaria; 41º56' latitude, 25º21' longitude; in Haskovo region
Status	Direct use -- developed
Temperature (ºC) from	40
Temperature (ºC) to	60

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.4
Potential (MWt)	6.2
Chronology	1994 to 1996 - Pilot project funded under Phare Project. Project executed by COWI (Denmark) and Energy project (Bulgaria). An installation costing €20,000 for heating of the Municipality of the town of Haskovo and a kindergarten was constructed. The installed capacity is 0.20 MWt. 2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for space heating and balneology at Mineralni Bani-Haskovo. Flow rate is 35.0 l/s; Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Iakoruda***
Location	41º58' latitude, 23º41' longitude
Status	Direct use -- developed
Temperature (ºC) from	43
Temperature (ºC) to	77
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt)	0
Chronology	
Notes	Estimated reservoir temperature is 77ºC (Bojadgieva et al., 1995).

Site/Project Name	***Illientzi***
Location	42º44' latitude, 23º26' longitude
Status	Feasibility study
Temperature (ºC) from	52
Temperature (ºC) to	58
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Estimated reservoir temperature is 58ºC (Bojadgieva et al., 1995).

Site/Project Name	***Iskar***
Location	42º28' latitude, 23º33' longitude
Status	Reconnaissance
Temperature (ºC) from	25
Temperature (ºC) to	0

Bulgaria

Installed capacity (MWe) 0

Potential (MWe) 0

Installed capacity (MWt) 0

Potential (MWt) 0

Chronology

Notes Flow rate is 0.5 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name ***Ivaniane***

Location 43º41' latitude, 23º19' longitude

Status Feasibility study

Temperature (ºC) from 20

Temperature (ºC) to 37

Installed capacity (MWe) 0

Potential (MWe) 0

Installed capacity (MWt) 0

Potential (MWt) 0

Chronology

Notes Flow rate is 6.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Estimated reservoir temperature is 37ºC (Bojadgieva et al., 1995).

Site/Project Name ***Jagoda***

Bulgaria

Location	42º32' latitude, 25º35' longitude
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	61
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 12.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 61ºC (Bojadgieva et al., 1995).

Site/Project Name	***Jeleznitsa***
Location	42º33' latitude, 23º24' longitude
Status	Feasibility study
Temperature (ºC) from	21
Temperature (ºC) to	32
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt)	0
Chronology	
Notes	Flow rate is 6.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Kableshkovo***
Location	42º39' latitude, 27º35' longitude
Status	Prefeasibility study
Temperature (ºC) from	22
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 0.3 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Kamenar TK-1***
Location	In Bourgas region
Status	Preliminary identification/repo
Temperature (ºC) from	22
Temperature (ºC) to	0

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Kamenitsa***
Location	42º03' latitude, 23º59' longitude; in Plovdiv region; in southwestern Bulgaria; in the Rhodope Mountains
Status	Direct use -- developed
Temperature (ºC) from	53
Temperature (ºC) to	91
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for balneology and greenhouses

Flow rate is 25.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Surface temperatures range from 7-89ºC, pH from 6.36-8.27, and TDS from 109-750 mg/l (Veldeman et al., 1990).

Site/Project Name	***Karnobat***
Location	42º36' latitude, 26º54' longitude; in Bourgas region
Status	Feasibility study
Temperature (ºC) from	22
Temperature (ºC) to	24
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Geothermal resource includes wells Karnobat-1 and Karnobat-14.

Site/Project Name	***Katuntzi***
Location	In the Struma (Strymon) rift valley; in Sofia region
Status	Preliminary identification/repo
Temperature (ºC) from	38
Temperature (ºC) to	75

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	5.02
Chronology	
Notes	Measured temperature is 40ºC; estimated temperature is 75ºC; estimated thermal power is 5.02 MWt (Shterev et al., 1995).

Site/Project Name	***Kavarna***
Location	In northeastern Bulgaria; in Varna region
Status	Preliminary identification/repo
Temperature (ºC) from	30
Temperature (ºC) to	32
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 120-200 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Kazichane***

Bulgaria

Location	In west-central Bulgaria, southeast of Sofia
Status	Direct use -- developed
Temperature (ºC) from	64
Temperature (ºC) to	81
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	8.5
Potential (MWt)	0
Chronology	Early 1950s - Drilling for hot water and other purposes began. Currently - 139 deep wells have reached the main thermal reservoir; more than 40 are producing wells. The deepest is 1607 m deep. Maximum temperature is 81ºC. 2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for balneology and greenhouses.

Site/Project Name	***Kirkovo***
Location	41º19' latitude, 25º20' longitude
Status	Prefeasibility study
Temperature (ºC) from	22
Temperature (ºC) to	0

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 2.0 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Kjustendil***
Location	In southwestern Bulgaria; 42º18' latitude, 22º42' longitude; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	26
Temperature (ºC) to	76
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.5
Potential (MWt)	7.5
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for space heating, balneology, and greenhouses. Flow rate is 35.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

The flow rate is 35-50 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Kliment***
Location	42º34' latitude, 24º44' longitude; in Plovdiv region
Status	Feasibility study
Temperature (ºC) from	30
Temperature (ºC) to	62
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Estimated reservoir temperature is 62ºC (Bojadgieva et al., 1995).

Site/Project Name	***Klisura***
Location	42º42' latitude, 24º27' longitude; in Plovdiv region
Status	Prefeasibility study
Temperature (ºC) from	17
Temperature (ºC) to	21
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 11.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Kniazhevo***
Location	42º40' latitude, 23º14' longitude
Status	Direct use -- developed
Temperature (ºC) from	23
Temperature (ºC) to	40
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 4.4 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 40ºC (Bojadgieva et al., 1995).

Site/Project Name	***Korten***
Location	In central Bulgaria; in Bourgas region

Bulgaria

Status	Direct use -- developed
Temperature (ºC) from	56
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. The flow rate is 56-60 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Kostadinovo***
Location	
Status	Direct use -- developed
Temperature (ºC) from	35
Temperature (ºC) to	50
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.35
Potential (MWt)	0

Bulgaria

Chronology	
Notes	The geothermal resource is used for space heating, sanitary water, and balneology for a kindergarten.

Site/Project Name	***Kostenetz***
Location	42º16' latitude, 23º50' longitude; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	36
Temperature (ºC) to	88
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Flow rate is 30.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 88ºC (Bojadgieva et al., 1995).

Site/Project Name	***Kranevo***
Location	In Varna region
Status	Well(s) or hole(s) drilled

Bulgaria

Temperature (ºC) from	24
Temperature (ºC) to	30
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Geothermal resource includes wells Kranevo-1 and -2.

Site/Project Name	***Krasnovo***
Location	In central Bulgaria; 42º28' latitude, 24º29' longitude; in Plovdiv region
Status	Feasibility study
Temperature (ºC) from	21
Temperature (ºC) to	56
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 14.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Bulgaria

Site/Project Name	***Kraynitsi***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	21
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	1.88
Chronology	
Notes	Measured temperature is 21ºC; estimated temperature is 60ºC; estimated thermal power is 1.88 MWt (Shterev et al., 1995).

Site/Project Name	***Kresna***
Location	In Sofia region
Status	Preliminary identification/repo
Temperature (ºC) from	53
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Krichim***
Location	41º59' latitude, 24º28' longitude; in Plovdiv region
Status	Prefeasibility study
Temperature (ºC) from	28
Temperature (ºC) to	30
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 10.0 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Kromodovo***
Location	41º25' latitude, 23º25' longitude; in the Struma (Strymon) rift valley; in Sofia region
Status	Feasibility study
Temperature (ºC) from	23
Temperature (ºC) to	80

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	5.43
Chronology	
Notes	Measured temperature is 47ºC; estimated temperature is 80ºC; estimated thermal power is 5.43 MWt (Shterev et al., 1995).

Site/Project Name	***Krushuna***
Location	In the north-central part of the country; in Lovech region
Status	Preliminary identification/repo
Temperature (ºC) from	57
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 18-40 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Kuklen***

Bulgaria

Location	In Plovdiv region
Status	Preliminary identification/repo
Temperature (ºC) from	32
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Kumaritza***
Location	In Sofia City
Status	Preliminary identification/repo
Temperature (ºC) from	36
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Bulgaria

Chronology

Notes

Site/Project Name	***Kurilo***
Location	In Sofia City
Status	Preliminary identification/repo
Temperature (ºC) from	26
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Lenovo***
Location	In Plovdiv region
Status	Preliminary identification/repo
Temperature (ºC) from	48
Temperature (ºC) to	0
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Leshnitsa***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	35
Temperature (ºC) to	80
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	4.08
Chronology	
Notes	Measured temperature is 35ºC; estimated temperature is 80ºC; estimated thermal power is 4.08 MWt (Shterev et al., 1995).

Site/Project Name	***Levunovo***
Location	In southwestern Bulgaria; 41º29' latitude, 23º18' longitude; in the Struma (Strymon) rift valley; in Sofia region

Bulgaria

Status	Direct use -- developed
Temperature (ºC) from	40
Temperature (ºC) to	100
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2
Potential (MWt)	8.9
Chronology	1990 - Exploration, pumped well drilled to 300m. Flow rate of 10.0 kg/s; wellhead pressure of 0.2 bar (Bojadgieva et al., 1995). 2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for greenhouses. Flow rate is 10.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Measured temperature is 87ºC; estimated temperature is 100ºC; estimated thermal power is 8.90 MWt (Shterev et al., 1995).

Site/Project Name	***Lozenetz quarter***
Location	In Sofia City
Status	Preliminary identification/repo

Bulgaria

Temperature (ºC) from	48
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Ludzhene***
Location	In Plovdiv region; in southwestern Bulgaria; 42º02' latitude, 23º59' longitude; in the Rhodope Mountains
Status	Direct use -- developed
Temperature (ºC) from	22
Temperature (ºC) to	63
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for space heating and balneology.

Flow rate is 22.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Surface temperatures range from 39-55ºC, pH from 8.41-9.57, and TDS from 238-559 mg/l (Veldeman et al., 1990).

Site/Project Name	***Luka***
Location	In Bourgas region
Status	Preliminary identification/repo
Temperature (ºC) from	21
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Marash***
Location	In northeastern Bulgaria; in Varna region
Status	Direct use -- developed

Bulgaria

Temperature (ºC) from	40
Temperature (ºC) to	67
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.7
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology and greenhouses. The flow rate is 10-30 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Marikostinovo***
Location	In southwestern Bulgaria; 41º26' latitude, 23º19' longitude; in the Struma (Strymon) rift valley; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	42
Temperature (ºC) to	87
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.3
Potential (MWt)	8.78
Chronology	

Bulgaria

Notes	The geothermal resource is used for balneology and greenhouses. Flow rate is 15.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 87ºC (Bojadgieva et al., 1995). Estimated thermal power of 8.78 MWt (Shterev et al., 1995).

Site/Project Name	***Medovo***
Location	42º42' latitude, 27º31' longitude; in Bourgas region
Status	Prefeasibility study
Temperature (ºC) from	23
Temperature (ºC) to	64
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 12.0 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 64ºC (Bojadgieva et al., 1995).

Site/Project Name	***Merichleri***
Location	42º09' latitude, 25º30' longitude; in Haskovo region

Bulgaria

Status	Direct use -- developed
Temperature (ºC) from	21
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 6.0 l/s; Carbon, Sulphur, and Chlorine present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 60ºC (Bojadgieva et al., 1995).

Site/Project Name	***Mihalkovo***
Location	41º51' latitude, 24º26' longitude; in Plovdiv region
Status	Feasibility study
Temperature (ºC) from	13
Temperature (ºC) to	98
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Bulgaria

Chronology	
Notes	Flow rate is 30.0 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 98ºC (Bojadgieva et al., 1995).

Site/Project Name	***Momin prohod***
Location	In the west-central part of the country; 42º20' latitude, 23º53' longitude; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	41
Temperature (ºC) to	88
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.9
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the “Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets” project.
Notes	The geothermal resource is used for space heating and balneology. Flow rate is 15.0 l/s; Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 88ºC (Bojadgieva et al., 1995).

Site/Project Name	***Mramor***

Bulgaria

Location	42º46' latitude, 23º23' longitude
Status	Feasibility study
Temperature (ºC) from	42
Temperature (ºC) to	91
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Estimated reservoir temperature is 91ºC (Bojadgieva et al., 1995).

Site/Project Name	***Musomischta***
Location	41º35' latitude, 23º46' longitude
Status	Prefeasibility study
Temperature (ºC) from	21
Temperature (ºC) to	22
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Bulgaria

Chronology

Notes — Flow rate is 15.0 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Narechenski Bani***
Location	41º54' latitude, 24º44' longitude; in Plovdiv region
Status	Direct use -- developed
Temperature (ºC) from	21
Temperature (ºC) to	109
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Flow rate is 5.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 109ºC (Bojadgieva et al., 1995).

Site/Project Name	***Nevestino***
Location	42º16' latitude, 22º49' longitude; in Sofia region
Status	Direct use -- developed

Bulgaria

Temperature (ºC) from	23
Temperature (ºC) to	32
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 39.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Novo Hodzhovo***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	70
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	3.45
Chronology	
Notes	Estimated temperature is 70ºC; estimated thermal power is 3.45 MWt (Shterev et al., 1995).

Bulgaria

Site/Project Name	***Novo Konomladi***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	24
Temperature (ºC) to	70
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	3.45
Chronology	
Notes	Measured temperature is 24ºC; estimated temperature is 70ºC; estimated thermal power is 3.45 MWt (Shterev et al., 1995).

Site/Project Name	***Obedinenie***
Location	In Lovech region
Status	Preliminary identification/repo
Temperature (ºC) from	48
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Ognianovo***
Location	In the southwestern part of the country
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Osenovo***
Location	41º57' latitude, 23º14' longitude; in the Struma (Strymon) rift valley
Status	Prefeasibility study
Temperature (ºC) from	36
Temperature (ºC) to	75

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	3.76
Chronology	
Notes	Flow rate is 11.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 72ºC (Bojadgieva et al., 1995). Measured temperature is 59ºC; estimated temperature is 75ºC; estimated thermal power is 3.76 MWt (Shterev et al., 1995).

Site/Project Name	***Oshtava***
Location	41º48' latitude, 23º13' longitude; in the Struma (Strymon) rift valley; in Sofia region
Status	Prefeasibility study
Temperature (ºC) from	40
Temperature (ºC) to	75
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	5
Chronology	

Bulgaria

Notes	Flow rate is 5.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Measured temperature is 56ºC; estimated temperature is 75ºC; estimated thermal power is 5.00 MWt (Shterev et al., 1995).

Site/Project Name	***Ovcha Kupel***
Location	42º41' latitude, 23º16' longitude
Status	Direct use -- developed
Temperature (ºC) from	30
Temperature (ºC) to	32
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 10.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Ovcha moglia***
Location	In Lovech region
Status	Preliminary identification/repo
Temperature (ºC) from	45
Temperature (ºC) to	0

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Ovchartsi***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	70
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	3.45
Chronology	
Notes	Estimated temperature is 70ºC; estimated thermal power is 3.45 MWt (Shterev et al., 1995).

Site/Project Name	***Ovoshnik***
Location	In central Bulgaria; 42º37' latitude, 25º24' longitude; in Haskovo region

Bulgaria

Status	Feasibility study
Temperature (ºC) from	41
Temperature (ºC) to	78
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 38.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Palat***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	22
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	2.82
Chronology	

Bulgaria

Notes	Measured temperature is 22ºC; estimated temperature is 60ºC; estimated thermal power is 2.82 MWt (Shterev et al., 1995).

Site/Project Name	***Panagurishte***
Location	In central Bulgaria; in Plovdiv region
Status	Preliminary identification/repo
Temperature (ºC) from	48
Temperature (ºC) to	57
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 5-8 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Pancharevo***
Location	43º36' latitude, 23º24' longitude
Status	Direct use -- developed
Temperature (ºC) from	43
Temperature (ºC) to	48
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 12.5 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Pavel Banya***
Location	In central Bulgaria; 42º38' latitude, 25º19' longitude; in Haskovo region
Status	Direct use -- developed
Temperature (ºC) from	19
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1991 - Exploration, artesian well drilled to 483m; flow rate of 9.6kg/s (Bojadgieva et al., 1995). 2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for balneology. Flow rate is 18.0 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Estimated reservoir temperature is 90ºC (Bojadgieva et al., 1995).

Site/Project Name	***Pchelni Bani***
Location	In the west-central part of the country; 42º22' latitude, 23º46' longitude; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	72
Temperature (ºC) to	99
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.7
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for balneology and greenhouses. Flow rate is 12.0 l/s; Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 99ºC (Bojadgieva et al., 1995).

Site/Project Name	***Pesnopoi***
Location	42º28' latitude, 24º48' longitude; in Plovdiv region
Status	Feasibility study

Bulgaria

Temperature (ºC) from	30
Temperature (ºC) to	76
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 10.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 76ºC (Bojadgieva et al., 1995).

Site/Project Name	***Petrich***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	30
Temperature (ºC) to	75
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	6.27
Chronology	

Bulgaria

Notes	Measured temperature is 30ºC; estimated temperature is 75ºC; estimated thermal power is 6.27 MWt (Shterev et al., 1995).

Site/Project Name	***Pleven***
Location	In the north-central part of the country
Status	Preliminary identification/repo
Temperature (ºC) from	64
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 70-120 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Poibrene***
Location	In Plovdiv region
Status	Preliminary identification/repo
Temperature (ºC) from	38
Temperature (ºC) to	0
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Polianovo***
Location	In Bourgas region
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	40
Temperature (ºC) to	54
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1991 - Two exploration, artesian wells drilled to 433-500m. Flow rates of 0.7-18 kg/s; wellhead pressure of 0.4 bar (Bojadgieva et al., 1995).
Notes	

Site/Project Name	***Polski Trumbesh***
Location	In Lovech region

Bulgaria

Status	Preliminary identification/repo
Temperature (ºC) from	45
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Posestia***
Location	41º46' latitude, 24º26' longitude
Status	Feasibility study
Temperature (ºC) from	36
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	

Bulgaria

Notes	Flow rate is 1.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Rakitovo***
Location	41º56' latitude, 24º08' longitude; in Plovdiv region
Status	Feasibility study
Temperature (ºC) from	11
Temperature (ºC) to	51
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Surface temperatures range from 11-51ºC, pH from 7.82-9.79, and TDS from 311-399 mg/l (Veldeman et al., 1990).

Site/Project Name	***Ravno pole***
Location	42º39' latitude, 23º36' longitude; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	52
Temperature (ºC) to	68
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Estimated reservoir temperature is 68ºC (Bojadgieva et al., 1995).

Site/Project Name	***Ressen***
Location	In the north-central part of the country; in Lovech region
Status	Preliminary identification/repo
Temperature (ºC) from	55
Temperature (ºC) to	56
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 20-60 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Rila***
Location	42º07' latitude, 23º10' longitude; in the Struma (Strymon) rift valley

Bulgaria

Status Feasibility study

Temperature (ºC) from 32

Temperature (ºC) to 60

Installed capacity (MWe) 0

Potential (MWe) 0

Installed capacity (MWt) 0

Potential (MWt) 2.82

Chronology

Notes Measured temperature is 37ºC; estimated temperature is 60ºC; estimated thermal power is 2.82 MWt (Shterev et al., 1995).

Site/Project Name ***Roudartzi***

Location 42º36' latitude, 23º10' longitude; in Sofia region

Status Direct use -- developed

Temperature (ºC) from 16

Temperature (ºC) to 29

Installed capacity (MWe) 0

Potential (MWe) 0

Installed capacity (MWt) 0

Potential (MWt) 0

Chronology

Bulgaria

Notes	Flow rate is 26.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Roudnik***
Location	In Bourgas region
Status	Preliminary identification/repo
Temperature (ºC) from	24
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Rupite***
Location	In southwestern Bulgaria; 41º28' latitude, 23º15' longitude; in the Struma (Strymon) rift valley; in Sofia region
Status	Direct use -- developed
Temperature (ºC) from	73
Temperature (ºC) to	93
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	14.12
Chronology	1960s - The Bulgarian Academy of Sciences set up a farm for open mass cultivation and processing of microalgae (Chlorella and Scenedesmus) was established. The existence of a hydrothermal source which releases free CO_2 in the atmosphere proved to be a significant factor for economic efficiency of microalgal cultivation (Furnadzieva et al,1993).
Notes	The geothermal resource is used for aquaculture. The installations have a total area of 2690 m2 and produce about 5-6 tonnes/year of dry product. Due to their varied and rich chemical composition, microalgae are used in food, pharmaceutical, and cosmetic industries in Bulgaria. The farm operates from April-October. The use of geothermal energy and fluids optimizes the photosynthesis and decreases technological expenses. Flow rate is 34.0 l/s; Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 93ºC (Bojadgieva et al., 1995). Estimated thermal power is 14.12 MWt (Shterev et al., 1995).

Site/Project Name	***Rusalka***
Location	In northeastern Bulgaria
Status	Preliminary identification/repo
Temperature (ºC) from	32
Temperature (ºC) to	0

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 50-80 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Sadievo***
Location	In Bourgas region
Status	Preliminary identification/repo
Temperature (ºC) from	30
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Sandanski***
Location	In southwestern Bulgaria; 41º35' latitude, 23º17' longitude; in the Struma (Strymon) rift valley; in

Bulgaria

	Sofia region
Status	Direct use -- developed
Temperature (ºC) from	17
Temperature (ºC) to	108
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2.4
Potential (MWt)	8.37
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for space heating, air conditioning, balneology, and greenhouses. Sandanksi is famous throughout Europe for its mineral springs. There are eight spas in the town park and another three on the right side of the Sandanska Bistritza river. Flow rate is 21.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 108ºC (Bojadgieva et al., 1995). Measured temperature is 83ºC; estimated thermal power is 8.37 MWt (Shterev et al., 1995).

Site/Project Name	***Sapareva Banya***
Location	In southwestern Bulgaria; 42º17' latitude, 23º15' longitude; in the Struma (Strymon) rift valley; in Sofia region

Bulgaria

Status	Direct use -- developed
Temperature (ºC) from	33
Temperature (ºC) to	115
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.25
Potential (MWt)	10.9

Chronology

1994 to 1996 - Pilot project funded under the Phare Project. Equipment for heating and providing hot tap water for a building of the balneological complex was installed. The system has a capacity of 0.250 MWt. Permanent monitoring of its parameters is performed. The cost of the project was approximately $23,000.

2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.

2000 and 2001 - Princeton Energy Resources International, and Elisa Consult received a $48,000 EcoLinks grant to assess the potential of extending the geothermal energy use for all district heating needs of the Sapareva Banya community. Currently, the municipality is using geothermal on a small scale as an alternative to the use of fossil fuel. First, the US partner will analyze the current system and identify opportunities to improve it. Then they will estimate the geothermal potential of the local field as well as determine the heat and energy consumption in the city. Based on the findings, a technical and economic study will be prepared to evaluate developing a district-heating scheme, including a general system configuration, environmental impact, and cost estimates. The study will be the basis for obtaining future funding for the project.

Notes

The geothermal resource is used for space heating, balneology, and greenhouses.

Flow rate is 16.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Measured temperature is 101ºC; estimated temperature is 115ºC (Shterev et al., 1995).

A geothermal station with a capacity of 10.9 MWt is considered, the construction of which will require $2.7 million of primary capital investment (Hristov, et al., 2000).

Site/Project Name	***Shabla***
Location	In northeastern Bulgaria; in Varna region
Status	Preliminary identification/repo
Temperature (ºC) from	38
Temperature (ºC) to	39
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 150-200 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Shipkovski Bani***
Location	43º52' latitude, 24º32' longitude; in Lovech region
Status	Direct use -- developed

Bulgaria

Temperature (ºC) from	19
Temperature (ºC) to	36
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 40.0 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Simeonovgrad***
Location	In south-central Bulgaria; 42º02' latitude, 25º53' longitude; in Haskovo region
Status	Feasibility study
Temperature (ºC) from	21
Temperature (ºC) to	57
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.

Notes	Flow rate is 1.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Simitli***
Location	In southwestern Bulgaria; 41º54' latitude, 23º05' longitude; in the Struma (Strymon) rift valley; in Sofia region
Status	Feasibility study
Temperature (ºC) from	20
Temperature (ºC) to	80
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	19.86
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	Flow rate is 16.0 l/s; Sulphur present in fluid (Lawrence and Stoyanov, 1996). Measured temperatures are 35-63ºC; estimated temperatures are 70-80ºC; estimated thermal power is 19.86 MWt (Shterev et al., 1995).

Site/Project Name	***Slanchev briag***
Location	42º38' latitude, 27º28' longitude; in Bourgas region
Status	Direct use -- developed

Bulgaria

Temperature (ºC) from	31
Temperature (ºC) to	37
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Estimated reservoir temperature is 37ºC (Bojadgieva et al., 1995). Also known as "Sunny beach."

Site/Project Name	***Slatina***
Location	43º19' latitude, 23º11' longitude; in the Struma (Strymon) rift valley; in Montana region
Status	Prefeasibility study
Temperature (ºC) from	18
Temperature (ºC) to	50
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	3.66
Chronology	

Bulgaria

Notes	Measured temperature is 25ºC; estimated temperature is 50ºC; estimated thermal power is3.66 MWt (Shterev et al., 1995).(Shterev et al., 1995).

Site/Project Name	***Slavianovo***
Location	In Lovech region
Status	Preliminary identification/repo
Temperature (ºC) from	45
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Slivenski Bani***
Location	In central Bulgaria; 42º36' latitude, 26º14' longitude; in Bourgas region
Status	Direct use -- developed
Temperature (ºC) from	42
Temperature (ºC) to	50
Installed capacity (MWe)	0

Bulgaria

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Flow rate is 17.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Sofia***
Location	In west-central Bulgaria; 42º42' latitude, 23º19' longitude
Status	Direct use -- developed
Temperature (ºC) from	47
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	Early 1950s - Drilling for hot water and other purposes began. 1992 - Production, pumped well drilled to 550 m. Flow rate of 3.0 kg/s; wellhead pressure of 1.29 bar (Bojadgieva et al., 1995). Currently - 139 deep wells have reached the main thermal reservoir; more than 40 are producing

	wells. The deepest is 1607 m deep. Maximum temperature is 81ºC.
Notes	The geothermal resource is used for balneology. Flow rate is 17.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). The highest predicted temperatures in the reservoir are above 90ºC. Based on all geothermometer data, it is possible that water with a relatively high temperature can be found in the northern part of the city of Sofia (Hristov and Pentcheva, 1999).

Site/Project Name	***Somitlii***
Location	
Status	Direct use -- developed
Temperature (ºC) from	62
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.8
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology and greenhouses.

Site/Project Name	***Spanchevtzi***
Location	43º10' latitude, 23º15' longitude; in Montana region

Bulgaria

Status	Prefeasibility study
Temperature (ºC) from	14
Temperature (ºC) to	50
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 9.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 50ºC (Bojadgieva et al., 1995).

Site/Project Name	***Spatovo***
Location	41º29' latitude, 23º21' longitude; in the Struma (Strymon) rift valley; in Sofia region
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	37
Temperature (ºC) to	80
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	5.43

Bulgaria

Chronology	1991 - Exploration, artesian well drilled to 700m. Flow rate of 4.0 kg/s; wellhead pressure of 0.44 bar (Bojadgieva et al., 1995).
Notes	Measured temperature is 38ºC; estimated temperature is 80ºC; estimated thermal power is 5.43 MWt (Shterev et al., 1995).

Site/Project Name	***St. Karadzhovo***
Location	42º13' latitude, 26º50' longitude; in Bourgas region
Status	Direct use -- developed
Temperature (ºC) from	15
Temperature (ºC) to	22
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 4.9 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Staro Jelezare***
Location	42º27' latitude, 24º39' longitude
Status	Feasibility study
Temperature (ºC) from	20
Temperature (ºC) to	29

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 3.6 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Starozagorski Bani***
Location	42º27' latitude, 25º30' longitude; in Haskovo region
Status	Direct use -- developed
Temperature (ºC) from	36
Temperature (ºC) to	46
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Flow rate is 20.0 l/s; Carbon present in fluid (Lawrence and Stoyanov, 1996).

Bulgaria

Site/Project Name	***Stob***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	29
Temperature (ºC) to	50
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	1.46
Chronology	
Notes	Measured temperature is 29ºC; estimated temperature is 50ºC; estimated thermal power is 1.46 MWt (Shterev et al., 1995).

Site/Project Name	***Stoletovo***
Location	42º42' latitude, 24º34' longitude
Status	Prefeasibility study
Temperature (ºC) from	26
Temperature (ºC) to	47
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt)	0
Chronology	
Notes	Flow rate is 1.9 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 47ºC (Bojadgieva et al., 1995).

Site/Project Name	***Straldja***
Location	In the east-central part of the country
Status	Preliminary identification/repo
Temperature (ºC) from	77
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 12-20 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Strelcha***
Location	In central Bulgaria; 42º31' latitude, 24º19' longitude; in Plovdiv region
Status	Direct use -- developed

Bulgaria

Temperature (ºC) from	23
Temperature (ºC) to	62
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 20.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 62ºC (Bojadgieva et al., 1995).

Site/Project Name	***Struma***
Location	42º00' latitude, 23º04' longitude
Status	Prefeasibility study
Temperature (ºC) from	57
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	

Bulgaria

Notes

Site/Project Name	***Svetovrachene***
Location	42º46' latitude, 23º29' longitude
Status	Feasibility study
Temperature (ºC) from	48
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Svishtoff***
Location	In the north-central part of the country; in Lovech region
Status	Preliminary identification/repo
Temperature (ºC) from	48
Temperature (ºC) to	49
Installed capacity (MWe)	0
Potential (MWe)	0

Bulgaria

Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 42-100 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Svoboda quarter***
Location	In Sofia City
Status	Preliminary identification/repo
Temperature (ºC) from	50
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Targovishte***
Location	43º18' latitude, 26º31' longitude
Status	Direct use -- developed

Bulgaria

Temperature (ºC) from	27
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Topolitsa***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	19
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1994 - Exploration, pumped well drilled to 300m. Flow rate of 13.2 kg/s (Bojadgieva et al., 1995).
Notes	

Bulgaria

Site/Project Name	***Topolovo***
Location	In Plovdiv region
Status	Preliminary identification/repo
Temperature (ºC) from	60
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Touzlata***
Location	In Varna region
Status	Preliminary identification/repo
Temperature (ºC) from	32
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Trebich***
Location	In Sofia City
Status	Preliminary identification/repo
Temperature (ºC) from	51
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Troyanovo***
Location	In Bourgas region
Status	Preliminary identification/repo
Temperature (ºC) from	21
Temperature (ºC) to	0

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Varna City***
Location	On the northern Black Sea coast; in Varna region
Status	Direct use -- developed
Temperature (ºC) from	50
Temperature (ºC) to	55
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	8.6
Potential (MWt)	43.6
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the "Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets" project.
Notes	The geothermal resource is used for space heating, air conditioning, and balneology at the Varna-2 Sport Palace.

Bulgaria

The recreation spa center at Varna is Bulgaria's biggest system for the complex use of geothermal waters for space heating and air-conditioning. Its total installed capacity is 15 MWt, out of which 5.8 MWt is for heat pumps and 9.2 MWt for the fossil fuel boiler.

The geothermal stations are mainly supplied by imported equipment that has been designed and constructed by Bulgarian companies. French companies VICARB and CIAT supplied the plate heat exchangers for the geothermal stations. Bulgarian plate heat exchangers have shown insufficient operating characteristics and shorter lifetime compared to the imported ones. Heat pumps were supplied by the Swiss company SULTZER and the US companies MC QUAY and TRANE. Two Bulgarian heat pumps with a condensing capacity of 0.25 MWt have been installed as experimental samples in one geothermal station.

Site/Project Name	***Varna-Droujba***
Location	On the northern Black Sea coast; in Varna region
Status	Direct use -- developed
Temperature (ºC) from	27
Temperature (ºC) to	69
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	4
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the “Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets” project.
Notes	The geothermal resource is used for space heating, air conditioning, and balneology at the St.

Konstantin and Elena Resort.

The flow rate is 315-500 dm3/s (Peneve and Shterev, 2000).

Two wells are used as thermal sources for the heat pumps. One has a flow rate of 35 l/s and a temperature of 43ºC; the other has a flow rate of 40 l/s and a temperature of 41ºC. A submersible pump is used in the second well. Thermal water passes directly through the evaporators, gets cooled to 27–33ºC, and is used for medical bath treatment afterwards (Hristov et al., 2000).

Site/Project Name	***Varna-Evkisograd***
Location	On the Northern Black Sea coast in northeastern Bulgaria; in Varna region
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	2000 - Installation examined by European Union ENERGIE team as part of the “Promotion and Dissemination of Successful Geothermal Technologies in the Bulgarian and Northern Greece Markets” project.
Notes	The geothermal resource has an industrial use. Iodine, bromine, boron, strontium, etc. are extracted from the thermal water.

Bulgaria

Site/Project Name	***Varna-South***
Location	On the Northern Black Sea coast in northeastern Bulgaria; in Varna region
Status	Direct use -- developed
Temperature (ºC) from	51
Temperature (ºC) to	55
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1992 - Production, artesian well drilled to 2000m. Flow rate of 48 kg/s; wellhead pressure of 3.02 bar (Bojadgieva et al., 1995).
Notes	The flow rate is 100-200 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Varshets***
Location	43º12' latitude, 23º19' longitude
Status	Direct use -- developed
Temperature (ºC) from	20
Temperature (ºC) to	49
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt)	0
Chronology	
Notes	Flow rate is 15.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Estimated reservoir temperature is 49ºC (Bojadgieva et al., 1995).

Site/Project Name	***Varvara***
Location	In southwestern Bulgaria; 42º08' latitude, 24º07' longitude; in Plovdiv region
Status	Direct use -- developed
Temperature (ºC) from	14
Temperature (ºC) to	91
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology and greenhouses. Flow rate is 24.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996). Surface temperatures range from 14.5-81ºC, pH from 7.47-8.69, and TDS from 320-728 mg/l (Veldeman et al., 1990).

Bulgaria

Site/Project Name	***Vidin***
Location	In the northwestern corner of the country
Status	Preliminary identification/repo
Temperature (ºC) from	50
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The flow rate is 30-50 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Vlahi***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	23
Temperature (ºC) to	75
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt)	3.76
Chronology	
Notes	Measured temperature is 23ºC; estimated temperature is 75ºC; estimated thermal power is 3.76 MWt (Shterev et al., 1995).

Site/Project Name	***Vlahovo***
Location	41º34' latitude, 24º50' longitude
Status	Prefeasibility study
Temperature (ºC) from	20
Temperature (ºC) to	23
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Flow rate is 5.0 l/s; Carbon and Sulphur present in fluid (Lawrence and Stoyanov, 1996).

Site/Project Name	***Voivodino***
Location	In Plovdiv region
Status	Preliminary identification/repo

Bulgaria

Temperature (ºC) from	32
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Vranya***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	22
Temperature (ºC) to	75
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	5.02
Chronology	
Notes	Measured temperature is 22ºC; estimated temperature is 75ºC; estimated thermal power is 5.02 MWt (Shterev et al., 1995).

Bulgaria

Site/Project Name	***Vurshech***
Location	In Montana region
Status	Preliminary identification/repo
Temperature (ºC) from	37
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Yagoda***
Location	In central Bulgaria; in Haskovo region
Status	Preliminary identification/repo
Temperature (ºC) from	40
Temperature (ºC) to	46
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Bulgaria

Potential (MWt)	0
Chronology	
Notes	The flow rate is 8-20 dm3/s (Peneve and Shterev, 2000).

Site/Project Name	***Yakoruda***
Location	In Sofia region
Status	Preliminary identification/repo
Temperature (ºC) from	42
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Zeleni dol***
Location	In the Struma (Strymon) rift valley
Status	Preliminary identification/repo
Temperature (ºC) from	61
Temperature (ºC) to	75

Bulgaria

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	6.27
Chronology	
Notes	Measured temperature is 61ºC; estimated temperature is 75ºC; estimated thermal power is 6.27 MWt (Shterev et al., 1995).

Site/Project Name	***Zlataritsa***
Location	41º54' latitude, 23º39' longitude
Status	Feasibility study
Temperature (ºC) from	36
Temperature (ºC) to	41
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Estimated reservoir temperature is 41ºC (Bojadgieva et al., 1995).

Site/Project Name	***Zlatni Pyasatzi***

Bulgaria

Location	On the Black Sea; in Varna region
Status	Direct use -- developed
Temperature (ºC) from	21
Temperature (ºC) to	38
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	3.45
Potential (MWt)	0
Chronology	
Notes	The geothermal resource, known as "Golden Sands," is used for space heating, air conditioning, and balneology. The flow rate is 100-200 dm3/s (Peneve and Shterev, 2000).

Czech Republic

Site/Project Name	***Becvou***
Location	In Moravia
Status	Preliminary identification/repo
Temperature (ºC) from	22
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The spring has a temperature of 22.5ºC and a flow rate of 16 l/sec (KAPA, 1999).

Site/Project Name	***Bludov Lazne***
Location	In Moravia
Status	Preliminary identification/repo
Temperature (ºC) from	28
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Czech Republic

Potential (MWt) 0

Chronology

Notes The spring has a temperature of 28ºC and a flow rate of 7 l/sec (KAPA, 1999).

Site/Project Name ***Bozi Dar***

Location Close to the border with Germany; in the Doupovske vrchy region

Status Prefeasibility study

Temperature (ºC) from 0

Temperature (ºC) to 0

Installed capacity (MWe) 0

Potential (MWe) 0

Installed capacity (MWt) 0

Potential (MWt) 0

Chronology

Notes Potential of geothermal energy utilization as a source for geothermal power plant is under investigation (Myslil and Stibitz, 2000).

Site/Project Name ***Breclav***

Location

Status Feasibility study

Czech Republic

Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	15
Chronology	
Notes	A feasibility study has shown a potential of heat pump installations of 15 MW for district heating.

Site/Project Name	***Darkov***
Location	
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology at Darkov Spa.

Czech Republic

Site/Project Name	***Decin***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1995 to 2000 - Project received support from the Danish Government through the DANCEE program. 2001 - MVV EPS, a subsidiary of MVV Energie (Germany) is building a geothermal heating plant in Decin. The plant will heat half the town with a total investment of US$10.8 million. York is supplying geothermal heat pumps. MVV EPS has a 5% share in the Czech heating market.
Notes	The geothermal resource is used for district heating.

Site/Project Name	***Doupovske vrchy***
Location	
Status	Prefeasibility study
Temperature (ºC) from	0
Temperature (ºC) to	0

Czech Republic

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Potential of geothermal energy utilization as a source for geothermal power plant is under investigation (Myslil and Stibitz, 2000).

Site/Project Name	***Jachmyov***
Location	In the northwestern part of the country; near the German border; in Zapadocesky kraj
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	32
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. There are radioactive thermal springs in Jachymov, but their temperature is only 32°C. These thermal waters have accumulated in a 600m deep old silver and

uranium mine (KAPA, 1999).

Site/Project Name	***Janske Lazne***
Location	In the northeastern part of the country; near the border with Poland; on the southwest-east border of the Krkonose granite massif
Status	Direct use -- developed
Temperature (ºC) from	18
Temperature (ºC) to	32
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. The spa Janske Lazne has thermal springs of 18 to 32°C.

Site/Project Name	***Karlovy Vary (Karlsbad)***
Location	In the Krusne Hory foreland rift zone; in the northwestern part of the country; near the German border; 142 km west of Prague; in the valley of the Tepla River valley
Status	Direct use -- developed

Czech Republic

Temperature (ºC) from	35
Temperature (ºC) to	72
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Chronology

1338 - Karlsbad founded by the Bohemian king and Roman emperor, Charles IV.

1911 - Colonade constructed which contained 4 wells (50-90m deep) producing 72ºC water. This facility also contains a geyser, high in CO_2 and discharging 100 l/min, with a maximum head of 15 m (Paces, 1988; Lund, 1992).

1935 - Program to seal the river bed was begun as the leakage of thermal springs into the Tepla River bed have affected the flows of the springs used for curative purposes. A clay-cement mixture was used to seal the bottom and new excavation in the city is not allowed below 367 m (Lund, 1992).

Notes

The geothermal resource is used for balneology at the world famous international spa.

Karlsbad is the warmest and most important natural geothermal spring in the Czech Republic, and has been used as a spa for over 600 years. The famous traveler Alexander Humboldt described the Karlsbad spa resort as a diamond set in an emerald clasp.

Research by balneologists has shown that the greatest success with these waters is achieved in the treatment of chronic illnesses of the digestive system (intestinal and stomach) and a number of metabolic troubles. Good results have also been achieved in the treatment of diabetes.

Treatment takes place at Spa V and the Thermal Spa Sanatorium with includes a large open-air swimming pool filled with mineral water.

Czech Republic

A total of 132 springs have been identified, with 12 main ones, producing a total of 2000 l/min. According to tradition,
the "thirteenth spring" is Karlovarska Becherovka, a local alcoholic drink (Lund, 1992).

The mineral water is of the Na-HCO3-SO4-Cl-type. Springs rise on the crossing of a three-fault system: the transversal, north-south and west-east faults confining the Krusne Hory foreland rift zone (KAPA, 1999). In addition, 180 tons of mineral salts are produced annually and exported for their curative properties (Lund, 1992).

Site/Project Name	***Marianske Lazn (Marienbad)***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Musov***
Location	

Czech Republic

Status	Preliminary identification/repo
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The site has been preliminarily studied and prepared for the project of utilization for thermal spas, heating, swimming pool and greenhouses (Myslil and Stibitz, 2000).

Site/Project Name	***Pisek***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	

Czech Republic

Notes	The site has been preliminarily studied and prepared for the project of utilization for thermal spas, heating, swimming pool and glass-houses (Myslil and Stibitz, 2000).

Site/Project Name	***Prokop***
Location	In the Pribram ore mining district
Status	Direct use -- developed
Temperature (ºC) from	28
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for heating. A heat pump with 1 MW output has been installed at the Prokop Mine. Warm water is pumped from the Prokop shaft; the heat pump increases the water temperature to heat the mine facilities and adjacent administrative buildings (Myslil and Stibitz, 2000).

Site/Project Name	***Slatinice***
Location	In Moravia
Status	Preliminary identification/repo

Czech Republic

Temperature (ºC) from	21
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The spring has a temperature of 21ºC and a flow rate of 10 l/sec (KAPA, 1999).

Site/Project Name	***Strekov***
Location	In the Aussig region
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for industry and balneology. The thermal water from the Cretaceous aquifer is used for the industry (soap factories) and for the heating of open swimming pool in Strekov.

Czech Republic

Site/Project Name	***Teplice***
Location	In the northwestern part of the country; near the German border; in Severocesky kraj; in the Krušne Hory foreland rift zone
Status	Direct use -- developed
Temperature (ºC) from	42
Temperature (ºC) to	46
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology at Teplice Spa. Thermal water circulates in the fractured system of carboniferous quartz porphyry. There are many small springs with differing temperatures. The thermal water is captured in a deep well (900m), its yield is about 25 l/sec with a temperature of 42.0 to 45.8°C. The Pravridlo spring has a mineralization of about 1g/l of the Na-HCO3-type. Some of the small mineral springs are radioactive. (KAPA, 1999).

Site/Project Name	***Trekov***
Location	
Status	Preliminary identification/repo

Czech Republic

Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Velke Losiny***
Location	In Moravia
Status	Direct use -- developed
Temperature (ºC) from	34
Temperature (ºC) to	36
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology at Velke Losiny Spa.

The spring has a flow rate of 15 l/sec (KAPA, 1999).

Romania

Site/Project Name	***Acas***
Location	47.55 Latitude, 22.47 Longitude
Status	Direct use -- developed
Temperature (ºC) from	65
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2.2
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for greenhouses and balneology. Flow rate is 15 kg/s; inlet and outlet temperatures are 65ºC and 30ºC, respectively; annual energy utilization is 36.9 TJ; capacity factor is 53% (Cohut and Bendea, 2000).

Site/Project Name	***Alesd***
Location	47.04 Latitude, 22.24 Longitude
Status	Direct use -- developed
Temperature (ºC) from	52
Temperature (ºC) to	0
Installed capacity (MWe)	0

Romania

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Arad***
Location	46.11 Latitude, 21.19 Longitude; in western Romania
Status	Direct use -- developed
Temperature (ºC) from	40
Temperature (ºC) to	42
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.8
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Flow rate is 12 kg/s; inlet and outlet temperatures are 40ºC and 25ºC, respectively; annual energy utilization is 13.8 TJ; capacity factor is 58% (Cohut and Bendea, 2000).

Site/Project Name	***Aviatiei***

Romania

Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1994 - Exploration pumped well drilled to 2100 m.
Notes	

Site/Project Name	***Avitim***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	51
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0.2
Chronology	1991 - Exploration pumped well drilled to 1304 m; flow rate of 4 kg/s, wellhead pressure of -30 m,

and heat output of 0.2 MWt.

Notes

Site/Project Name	***Balotesti***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	74
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	4
Chronology	1991 - Exploration pumped well drilled to 3304 m; flow rate of 28 kg/s, wellhead pressure of -40 m, and heat output of 4.0 MWt.
Notes	

Site/Project Name	***Beius***
Location	
Status	Direct use -- developed
Temperature (ºC) from	83
Temperature (ºC) to	0

Romania

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	5.5
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for heating and balneology. Flow rate is 25 kg/s; inlet and outlet temperatures are 83ºC and 30ºC, respectively; annual energy utilization is 104.9 TJ; capacity factor is 60% (Cohut and Bendea, 2000).

Site/Project Name	***Beltiug***
Location	
Status	Direct use -- developed
Temperature (ºC) from	75
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.1
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology.

Flow rate is 6 kg/s; inlet and outlet temperatures are 75ºC and 30ºC, respectively; annual energy utilization is 23.7 TJ; capacity factor is 67% (Cohut and Bendea, 2000).

Site/Project Name	***Berecsau Mic***
Location	45.46 Latitude, 22.01 Longitude
Status	Preliminary identification/repo
Temperature (ºC) from	77
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Beregsau***
Location	
Status	Direct use -- developed
Temperature (ºC) from	75
Temperature (ºC) to	0
Installed capacity (MWe)	0

Romania

Potential (MWe)	0
Installed capacity (MWt)	1.3
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for industrial process heat and balneology. Flow rate is 6 kg/s; inlet and outlet temperatures are 75ºC and 25ºC, respectively; annual energy utilization is 19.8 TJ; capacity factor is 50% (Cohut and Bendea, 2000).

Site/Project Name	***Boghis***
Location	47.09 Latitude, 22.44 Longitude
Status	Direct use -- developed
Temperature (ºC) from	45
Temperature (ºC) to	48
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology and heating. Flow rate is 12 kg/s; inlet and outlet temperatures are 45ºC and 25ºC, respectively; annual energy utilization is 26.4 TJ; capacity factor is 83% (Cohut and Bendea, 2000).

Romania

Site/Project Name	***Bors***
Location	47.07 Latitude, 21.49 Longitude; about 6 km northwest of Oradea; in northwestern Romania
Status	Direct use -- developed
Temperature (ºC) from	90
Temperature (ºC) to	135
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	7.8
Potential (MWt)	0
Chronology	1985 - Two wells began to be used for injection alternatively; resulted in pressure restoration by 4-5 atm without affecting the water temperature (Butac and Opran, date unknown). 1995 to 1997 - Geothermal waters were sampled and analyzed from well Bors-529. Wellhead temperatures measured during collection of water samples were 90-115ºC. Based on the chemical composition of the water, the Watch program was used to predict the potential danger of scaling. The ionic balances calculated by the Watch program gave values of -0.69-5.88. The structural analysis of deposition showed that at the wellhead temperature, aragonite depositions are formed mainly by a crystalline phase (Stanasel, 2000).
Notes	The geothermal resource is used to heat 6 hectares of greenhouses. Flow rate is 25 kg/s; inlet and outlet temperatures are 115ºC and 40ºC, respectively; annual energy utilization is 118.7 TJ; capacity factor is 48% (Cohut and Bendea, 2000). At present, 3 wells are exploited, with a total flow rate of 50l/s and 2 other wells are used for

reinjection, at a pressure that does not exceed 6 bar. The wells are producing with wellhead pressures of 10-15 bar and a wellhead temperature of 115ºC. The gases are partially separated at 7 bar, that is the operating pressure, the water is passed through the heat exchangers and reinjected.

The Bors geothermal reservoir is situated in the same fissured carbonate formations as Oradea. This is a tectonic closed aquifer with a small surface area of 12 km2. The geothermal water has a mineralization of 13 g/l, a GWR of 5 Nm3/m3 and a high scaling potential. The dissolved gasses are 70% COL and 30% CH4. The reservoir temperature is greater than 130ºC at the average depth of 2,500 m. The artesian production of the wells can be maintained only by reinjecting the whole amount of extracted geothermal water (Cohut and Bendea, 1999).

Site/Project Name	***Braila***
Location	In eastern Romania, south of Galati
Status	Preliminary identification/repo
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Brasov***

Romania

Location	In central Romania, northeast of the Olt Valley
Status	Preliminary identification/repo
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Buftea***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	40
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Romania

Chronology	1990 - Exploration pumped well drilled to 3202 m; flow rate of 0.7 kg/s.
Notes	

Site/Project Name	***Caciulata***
Location	In the Olt Valley in the south central part of the country
Status	Direct use -- developed
Temperature (ºC) from	37
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1893 - Well drilled.
Notes	The geothermal resource is used for balneology at the Caciulata Spa.

In the Olt Valley, three district heating systems are in operation in the town of Cozia, in Caciulata Spa, and in Calimanesti Spa, each using geothermal water produced by a single artesian well with flow rates of 12-18 l/s and wellhead temperatures of 92-95ºC (Rosca and Bendea, 1999).

An INCO-Copenicus project has been approved by the European Commission to separate combustible gases from the geothermal fluid, and use them in boilers, increasing energy output by 15%. The district heating system to be completed in the project will use geothermal fluid produced by one well in Caciulata and tap into the Cozia-Caciulata geothermal reservoir. The installed power will be about 3.5 MWt; annual energy production will exceed 90,000 GJ (assuming 300 operating days) and save 2,500 t.o.e.. annually.

Site/Project Name	***Calacea***
Location	
Status	Preliminary identification/repo
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Calimanesti***
Location	In the Olt Valley; in the south central part of the country
Status	Direct use -- developed
Temperature (ºC) from	90
Temperature (ºC) to	95
Installed capacity (MWe)	0
Potential (MWe)	0

Romania

Installed capacity (MWt) 8

Potential (MWt) 18

Chronology 1992 - Exploration artesian well drilled to 3250 m; flow rate of 28 kg/s, wellhead pressure of 6 bar, and heat output of 6.0 MWt.

Notes The geothermal resource is used for space heating, balneology, and recreation.

In the Olt Valley, three district heating systems are in operation in the town of Cozia, in Caciulata Spa, and in Calimanesti Spa, each using geothermal water produced by a single artesian well with flow rates of 12-18 l/s and wellhead temperatures of 92-95ºC (Rosca and Bendea, 1999).

An INCO-Copenicus project has been approved by the European Commission to separate combustible gases from the geothermal fluid, and use them in boilers, increasing energy output by 15%. The district heating system to be completed in the project will use geothermal fluid produced by one well in Caciulata and tap into the Cozia-Caciulata geothermal reservoir. The installed power will be about 3.5 MWt; annual energy production will exceed 90,000 GJ (assuming 300 operating days) and save 2,500 t.o.e. annually.

The Cozia-Calimanesti geothermal reservoir produces artesian geothermal water, with a flow rate of 20-25 Vs and wellhead pressure of 16-20 bar, from fissured siltstones of Senonian age. The reservoir depth is 1,900-2,200 m, the wellhead temperature is 90-95°C, the mineralization of water is 14 g/l and there is no scaling. The GWR is 2.0 Nm3/m³ (90% methane).

Although the reservoir has been exploited for over 10 years, there is no interference between the wells and no pressure draw down. The thermal potential that is possible to be achieved from 3 wells is 18 MWt but at present, only 8 MWt is used.

Site/Project Name ***Carei***

Location 47.42 Latitude, 22.18 Longitude

Romania

Status	Direct use -- developed
Temperature (ºC) from	45
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.3
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology and for industrial process heat. Flow rate is 5 kg/s; inlet and outlet temperatures are 45ºC and 30ºC, respectively; annual energy utilization is 5.9 TJ; capacity factor is 60% (Cohut and Bendea, 2000).

Site/Project Name	***Cighid***
Location	Approximately 10 km southeast of Salonta
Status	Direct use -- developed
Temperature (ºC) from	72
Temperature (ºC) to	86
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2
Potential (MWt)	0

Romania

Chronology

Notes — The geothermal resource is used for heating, balneology, and greenhouses.

Flow rate is 10 kg/s; inlet and outlet temperatures are 72ºC and 25ºC, respectively; annual energy utilization is 37.2 TJ; capacity factor is 60% (Cohut and Bendea, 2000).

The Oradea division of Transgex SA completed a geothermal well which is producing geothermal water with an artesian flow rate of 15 l/s and 86°C from Pannonian sandstones. In the neogene depression of Beius a geothermal well producing from the fractured carbonate formations belonging to the Codru system was completed by the Oradea division of Transgex. The well has a potential of 25 l/s (using ESP) at 80ºC (Cohut and Bendea, 1999).

Site/Project Name	***Ciumeghiu***
Location	46.44 Latitude, 21.35 Longitude; in the Western Plain, south of Oradea
Status	Direct use -- developed
Temperature (ºC) from	84
Temperature (ºC) to	120
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2.9
Potential (MWt)	0

Chronology — 1995 to 1997 - Geothermal waters were sampled and analyzed from well Ciumeghiu-4668. Wellhead temperatures measured during collection of water samples were 84-101ºC. Based on the chemical composition of the water, the Watch program was used to predict the potential danger of scaling. The ionic balances calculated by the Watch program gave values of -1.09-3.69. The structural analysis of

	deposition showed that at the wellhead temperature, calcite and magnesium depositions are formed mainly by a crystalline phase (Stanasel, 2000).
Notes	The geothermal resource is used for greenhouses. Flow rate is 12 kg/s; inlet and outlet temperatures are 92ºC and 35ºC, respectively; annual energy utilization is 45.1 TJ; capacity factor is 50% (Cohut and Bendea, 2000). Geothermal water is produced by artesian flow with a wellhead temperature of 105°C and a mineralization of 5-6g/l with strong carbonate scaling. The reservoir was investigated by 4 wells, but only one is currently in use, with a capacity of 5 MWt (KAPA Systems, 1999). Geothermal water is produced by artesian Bow from the Pannonian gritstones with a wellhead temperature of 105°C and a mineralization of 5-6 g/l with strong carbonate scaling prevented by chemical treatment at the depth of 400 m (Cohut and Bendea, 1999). Three wells have been drilled in the area of Salonta-Madaras; two have been in operation for more than 15 years. The geothermal reservoir is located in the porous-permeable Lower Pannonian formations. The gases were separated in a very simple and efficient installation and were utilized for more than 10 years.

Site/Project Name	***Cluj-Napoca***
Location	In northern Romania; east of Oradea
Status	Preliminary identification/repo
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0

Romania

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Comlosu***
Location	45.54 Latitude, 20.37 Longitude
Status	Direct use -- developed
Temperature (ºC) from	81
Temperature (ºC) to	85
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2.3
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for heating and balneology. Flow rate is 10 kg/s; inlet and outlet temperatures are 81ºC and 25ºC, respectively; annual energy utilization is 44.3 TJ; capacity factor is 60% (Cohut and Bendea, 2000).

Site/Project Name	***Constanta***

Romania

Location	In southeastern Romania; near the Black Sea
Status	Preliminary identification/repo
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Covaci***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	53
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0.1

Romania

Chronology	1991 - Exploration artesian well drilled to 1451 m; flow rate of 2.5 kg/s, heat output of 0.1 MWt.
Notes	

Site/Project Name	***Cozia***
Location	In the Olt Valley in the south central part of the country
Status	Direct use -- developed
Temperature (ºC) from	90
Temperature (ºC) to	95
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology.

In the Olt Valley, three district heating systems are in operation in the town of Cozia, in Caciulata Spa, and in Calimanesti Spa, each using geothermal water produced by a single artesian well with flow rates of 12-18 l/s and wellhead temperatures of 92-95ºC (Rosca and Bendea, 1999).

An INCO-Copenicus project has been approved by the European Commission to separate combustible gases from the geothermal fluid, and use them in boilers, increasing energy output by 15%. The district heating system to be completed in the project will use geothermal fluid produced by one well in Caciulata and tap into the Cozia-Caciulata geothermal reservoir. The installed power will be about 3.5 MWt; annual energy production will exceed 90,000 GJ (assuming 300 operating days) and save 2,500 t.o.e.. annually.

The Cozia-Calimanesti geothermal reservoir produces artesian geothermal water, with a flow rate of 20-25 l/s and wellhead pressure of 16-20 bar, from fissured siltstones of Senonian age. The reservoir depth is 1900-2200m, the wellhead temperature is 90-95°C, the water mineralization is 14g/l. The gas water ratio (GWR) is 2Nm3/m3 (90% methane) (KAPA Systems, 1999).

Site/Project Name	***Craiova***
Location	In southern Romania; southeast of Herculane
Status	Preliminary identification/repo
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Curtici***
Location	46.21 Latitude, 21.19 Longitude; in western Romania; in Arad county
Status	Direct use -- developed

Romania

Temperature (ºC) from	63
Temperature (ºC) to	65
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	3.5
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for heating, greenhouses, and balneology. The system uses one well (1,300-1,400 m deep) which produces 10 l/s at a wellhead temperature of up to 70ºC. The Curtici system heats 280 flats (Rosca and Bendea, 1999). Flow rate is 22 kg/s; inlet and outlet temperatures are 63ºC and 25ºC, respectively; annual energy utilization is 70.2 TJ; capacity factor is 64% (Cohut and Bendea, 2000).

Site/Project Name	***Dorobanti***
Location	46.22 Latitude, 21.15 Longitude
Status	Direct use -- developed
Temperature (ºC) from	60
Temperature (ºC) to	74
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2.6

Romania

Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for greenhouses and balneology. Flow rate is 18 kg/s; inlet and outlet temperatures are 60ºC and 25ºC, respectively; annual energy utilization is 41.5 TJ; capacity factor is 50% (Cohut and Bendea, 2000).

Site/Project Name	***Felix Spa***
Location	47.00 Latitude, 22.01 Longitude; in the Precarpathian area
Status	Direct use -- developed
Temperature (ºC) from	34
Temperature (ºC) to	49
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	11.7
Potential (MWt)	0
Chronology	1885 - First geothermal well in Romania drilled. The well was 51 m deep, with a flow rate of 195 l/s, and a temperature of 49ºC. It is still operating.
Notes	The geothermal resource is used for health and recreational bathing and heating. Natural hot springs have been known since the time of the Roman Empire, when Dacia province boasted several famous health spas including Felix. The Felix Spa complex has several hotels and treatment facilities with a total of about 7,000 beds.

Flow rate is 140 kg/s; inlet and outlet temperatures are 45ºC and 25ºC, respectively; annual energy utilization is 216.0 TJ; capacity factor is 54% (Cohut and Bendea, 2000).

The Felix Spa reservoir is currently exploited by 6 wells, with depths of 50-450 m. The total flow rate available from these wells is 210 Vs. The geothermal water has wellhead temperatures of 36-48°C and is drinkable (Cohut and Bendea, 1999).

Both aquifers, the Triassic aquifer Oradea and the Cretaceous aquifer Felix spa, are hydrodynamically connected and are part of the active natural circuit of water (KAPA Systems, 1999).

Site/Project Name	***Galati***
Location	In eastern Romania, north of Braila
Status	Preliminary identification/repo
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Geoagiu***

Romania

Location	In the Precarpathian area
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Geothermal resource used for balneology. Natural hot springs have been known since the time of the Roman Empire, when Dacia province boasted several famous health spas including Geoagiu.

Site/Project Name	***Grabat***
Location	45.52 Latitude, 20.48 Longitude
Status	Direct use -- developed
Temperature (ºC) from	80
Temperature (ºC) to	88
Installed capacity (MWe)	0
Potential (MWe)	0

Romania

Installed capacity (MWt)	1.3
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for industrial process heat and balneology. Flow rate is 6 kg/s; inlet and outlet temperatures are 80ºC and 30ºC, respectively; annual energy utilization is 19.8 TJ; capacity factor is 50% (Cohut and Bendea, 2000).

Site/Project Name	***Herculane***
Location	44.50 Latitude, 22.30 Longitude; in the Precarpathian area; in southwestern Romania
Status	Direct use -- developed
Temperature (ºC) from	52
Temperature (ºC) to	70
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	8.5
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. Natural hot springs have been known since the time of the Roman Empire, when Dacia province boasted several famous health spas including Herculane.

Romania

	Flow rate is 75 kg/s; inlet and outlet temperatures are 52ºC and 25ºC, respectively; annual energy utilization is 148.0 TJ; capacity factor is 67% (Cohut and Bendea, 2000).

Site/Project Name	***Iasi***
Location	In northeastern Romania
Status	Preliminary identification/repo
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Insuratei***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	60
Temperature (ºC) to	0
Installed capacity (MWe)	0

Romania

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0.7
Chronology	1990 - Exploration artesian well drilled to 1551 m; flow rate of 8 kg/s, wellhead pressure of 1 bar, and heat output of 0.7 MWt.
Notes	

Site/Project Name	***Iratos***
Location	46.19 Latitude, 21.12 Longitude
Status	Direct use -- developed
Temperature (ºC) from	40
Temperature (ºC) to	64
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.4
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for industrial process heat and balneology. Flow rate is 5 kg/s; inlet and outlet temperatures are 40ºC and 20ºC, respectively; annual energy utilization is 7.9 TJ; capacity factor is 60% (Cohut and Bendea, 2000).

Romania

Site/Project Name	***Jimbolia***
Location	45.48 Latitude, 20.43 Longitude; in Timis county
Status	Direct use -- developed
Temperature (ºC) from	82
Temperature (ºC) to	88
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	10.9
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for industrial process heat, heating, greenhouses, and balneology. The geothermal resource is used to provide hot water and heat 800 flats. The system uses three wells with a total flow rate of 30 l/s and a wellhead temperature of 80ºC, and has two heat stations with peak load boilers (Rosca and Bendea, 1999). Flow rate is 50 kg/s; inlet and outlet temperatures are 82ºC and 30ºC, respectively; annual energy utilization is 240.1 TJ; capacity factor is 70% (Cohut and Bendea, 2000).

Site/Project Name	***Lenauheim***
Location	45.52 Latitude, 20.48 Longitude
Status	Preliminary identification/repo

Romania

Temperature (ºC) from	82
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Livada***
Location	47.03 Latitude, 21.50 Longitude
Status	Direct use -- developed
Temperature (ºC) from	88
Temperature (ºC) to	107
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2.2
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for heating, balneology, and fish and animal farming.

	Flow rate is 10 kg/s; inlet and outlet temperatures are 88ºC and 35ºC, respectively; annual energy utilization is 35.0 TJ; capacity factor is 50% (Cohut and Bendea, 2000).
Site/Project Name	***Lovrin***
Location	45.58 Latitude, 20.46 Longitude; in southwestern Romania; in Timis county
Status	Direct use -- developed
Temperature (ºC) from	81
Temperature (ºC) to	91
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	8.5
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for heating, greenhouses, and balneology. A 1,800 m-deep well produces an artesian discharge of 12 l/s with a wellhead temperature of 81ºC, heating 250 flats (Rosca and Bendea, 1999). Flow rate is 40 kg/s; inlet and outlet temperatures are 81ºC and 30ºC, respectively; annual energy utilization is 132.0 TJ; capacity factor is 49% (Cohut and Bendea, 2000).
Site/Project Name	***Macea***
Location	46.24 Latitude, 21.19 Longitude; in western Romania; in Arad county

Romania

Status	Direct use -- developed
Temperature (ºC) from	65
Temperature (ºC) to	72
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2.5
Potential (MWt)	0
Chronology	1982 - Well drilled; artesian flow rate of 7 l/s with a wellhead temperature of 61ºC.
Notes	The geothermal resource is used for heating, greenhouses, and balneology.

A heating system has been designed to heat the "Vasile Goldis" University, part of the non-profit "Vasile Goldis" Foundation, which is housed in and around the Macea Castle. Geothermal water will be used for space and tap water heating, indoor health bathing and treatment facilities, an outdoor swimming pool, and greenhouse heating. The whole system requires an installed capacity of about 1.3 MWt (Rosca and Bendea, 1999).

The current artesian well, drilled in 1982, cannot supply the total demand of the Macea Campus. With a submersible pump set at less than 150 m, it is possible to increase the flow rate to 15-16 l/s. The Macea Campus needs a flow rate of 12 l/s.

The annual energy savings are estimated at 440 t.o.e..

The Foundation must raise the necessary funds from grants and donations.

Flow rate is 15 kg/s; inlet and outlet temperatures are 65ºC and 25ºC, respectively; annual energy utilization is 42.2 TJ; capacity factor is 53% (Cohut and Bendea, 2000).

Romania

Site/Project Name	***Madaras***
Location	46.50 Latitude, 21.42 Longitude
Status	Direct use -- developed
Temperature (ºC) from	46
Temperature (ºC) to	62
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.4
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology and heating. Flow rate is 5 kg/s; inlet and outlet temperatures are 46ºC and 25ºC, respectively; annual energy utilization is 8.3 TJ; capacity factor is 60% (Cohut and Bendea, 2000).

Site/Project Name	***Mangalia***
Location	In southeastern Romania; near the Black Sea
Status	Preliminary identification/repo
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0

Romania

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Marghita***
Location	47.21 Latitude, 22.21 Longitude; in northwestern Romania; 50 km north of Oradea
Status	Direct use -- developed
Temperature (ºC) from	65
Temperature (ºC) to	85
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for hot water, heating, and balneology.

In Marghita (pop. 15,000), two pumped geothermal wells produce about 8 l/s each with wellhead temperatures of 65ºC. The geothermal water is used for space and tap water heating for 150 flats, and for tap water heating for 800 more flats (Rosca and Bendea, 1999).

Flow rate is 12 kg/s; inlet and outlet temperatures are 65ºC and 25ºC, respectively; annual energy utilization is 52.8 TJ; capacity factor is 83% (Cohut and Bendea, 2000).

Site/Project Name	***Mihai Bravu***
Location	47.16 Latitude, 21.57 Longitude
Status	Direct use -- developed
Temperature (ºC) from	60
Temperature (ºC) to	65
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for greenhouses and fish and animal farming. Flow rate is 6 kg/s; inlet and outlet temperatures are 65ºC and 25ºC, respectively; annual energy utilization is 15.8 TJ; capacity factor is 50% (Cohut and Bendea, 2000).

Site/Project Name	***Moara Vlasiei***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	76
Temperature (ºC) to	78

Romania

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	3.6
Chronology	1990 - Exploration pumped well drilled to 3028 m; flow rate of 24 kg/s, wellhead pressure of -40 m, and heat output of 3.6 MWt. 1991 - Exploration pumped well drilled to 2829 m; flow rate of 35 kg/s, wellhead pressure of -40 m, and heat output of 5.6 MWt.
Notes	

Site/Project Name	***Nadlac***
Location	46.10 Latitude, 20.45 Longitude; in western Romania; in Arad county
Status	Direct use -- developed
Temperature (ºC) from	78
Temperature (ºC) to	84
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for industrial process heat, heating, and balneology.

The system uses one well (1,300-1,400 m deep) which produces 10 l/s at a wellhead temperature of up to 70ºC. The Nadlac system heats 250 flats (Rosca and Bendea, 1999).

Flow rate is 10 kg/s; inlet and outlet temperatures are 78ºC and 30ºC, respectively; annual energy utilization is 50.6 TJ; capacity factor is 80% (Cohut and Bendea, 2000).

Site/Project Name	***North Bucharest***
Location	In southeastern Romania; south of Otopeni
Status	Direct use -- developed
Temperature (ºC) from	62
Temperature (ºC) to	85
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	5.4
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for heating and balneology. Flow rate is 35 kg/s; inlet and outlet temperatures are 62ºC and 25ºC, respectively; annual energy utilization is 65.0 TJ; capacity factor is 43% (Cohut and Bendea, 2000). The Austrian Government and the European Community are supporting the development of hotel spa projects in North Bucharest (Rosca and Bendea, 1999).

Romania

Site/Project Name	***Olanesti***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	90
Temperature (ºC) to	92
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1994 - Exploration artesian well drilled to 3000 m.
Notes	It is expected that an artesian flow rate of 200m³/h at a temperature of about 90-92°C will provide heating for a hotel complex (KAPA Systems, 1999).

Site/Project Name	***Olt Valey***
Location	45.16 Latitude, 24.20 Longitude
Status	Direct use -- developed
Temperature (ºC) from	92
Temperature (ºC) to	98
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	6.5

Romania

Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for heating and balneology. In the Olt Valley, three district heating systems are in operation in the town of Cozia, in Caciulata Spa, and in Calimanesti Spa, each using geothermal water produced by a single artesian well. Flow rate is 25 kg/s; inlet and outlet temperatures are 92ºC and 30ºC, respectively; annual energy utilization is 130.8 TJ; capacity factor is 64% (Cohut and Bendea, 2000).

Site/Project Name	***Oradea***
Location	47.04 Latitude, 21.56 Longitude; in northwestern Romania; close to the Hungarian border
Status	Direct use -- developed
Temperature (ºC) from	29
Temperature (ºC) to	105
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	18.8
Potential (MWt)	0
Chronology	1897 - Well drilled; encountered temperature of 29ºC. 1970 to 1980 - 12 wells were drilled ranging from 2500-3400 m deep. Wellhead temperatures of 70-105ºC and artesian flow rates of 5-35 l/s were encountered. All wells are currently in commercial exploitation for direct uses (Mitrofan, 2000).

Romania

1981 - Well No. 4796 was drilled on the University of Oradea campus under the National Geological Research Program which was funded by the Ministry of Science and Education. The National Geothermal Research Institute designed and developed a pilot binary cycle power plant using 90ºC water and carbon dioxide as the working fluid. The first installation used a piston engine for working fluid expansion and produced 1 MWe of electric power (Mircea and Cornel, 2000).

The PC version of the TOUGH2 computer code was used to model the low enthalpy geothermal well from the University of Oradea campus. More details on the model and its natural state, static, and dynamic calibration are given by Rosca and Antics (1999).

A heating system using geothermal energy was placed online on the campus of the University of Oradea. The system provides hot water and space heating for the campus as well as for three apartment blocks located nearby. The 2991 m-deep artesian well initially produced 2.5 l/s with a wellhead temperature of 68ºC. The system's maximum thermal power is 3.4 MWt (Rosca, 1993).

1983 - An acid job (1500 m3 of 1.5% HCl solution) was carried out in a well on the campus of the University of Oradea. Following the acid job, the artesian flow rate increased to 31 l/s, and the wellhead temperature reached 85ºC. The well has been producing, at different flow rates, almost continuously since the acid job.

1992 - Reinjection began with the first doublet in the Nafural district in Oradea city, in October.

1992 - The National Geothermal Research Center was established in Oradea as part of the university. This is also the location of the Romanian Geothermal Association's headquarters.

1996 - A new pilot power plant was designed using a turbine instead of a piston (Mircea and Cornel, 2000).

1997 - Based on a reservoir study conducted by Geonuid Inc. (summarized by Antics, 1997), the

Oradea Municipality, acting as the main sponsor and contracting authority, co-financed, together with the French Ministry of Industry and GPC Inc., a feasibility study on the "Development and Modernization of the Geothermal District Heating Facilities of the City of Oradea." The geothermal resource currently supplies about 55,000 MWth/yr or 4% of the City of Oradea's (pop. 230,000) heat needs.

Notes

The geothermal resource is used for space heating, sanitary hot water, industrial process heat (timber drying and milk pasteurization), greenhouses, balneology, and fish and animal farming.

The Oradea geothermal reservoir is one of more than 30 geothermal reservoirs with real development potential in the EU pre-accession countries.

Due to artesian discharge and limited reinjection of the heat-depleted geothermal fluid, the annual geothermal energy utilization is only 65 GWt , far below the reservoir potential. A fourfold increase in production from the Oradea geothermal reservoir is possible without any adverse effects if at least 70% of the extracted geothermal fluid is reinjected.

Two possible scenarios are envisaged to replace low-grade coal with natural gas and geothermal energy as heat sources for Oradea. In one scenario, geothermal energy supplies heat for culinary water heating and the base load for space heating in a limited number of substations, with peak load being produced by natural-gas-fired boilers. In the other scenario, the geothermal energy is only used for culinary water heating. In both scenarios, all substations are converted into heating plants with natural gas as the main energy source.

The main target of a geothermal program for Oradea is the development of the existing production and distribution infrastructure. Implementation would be by: artificial production using deep well pumps; the conversion of low-productivity wells into injection wells, to maintain the reservoir pressure and dispose of the heat depleted fluid; and connection of 5 geothermal doublets with the district heating system (Cohut et al., 1996).

The proposed system will provide a fourfold increase in geothermal energy production, from 65 to

250 GWht /yr. Year-round delivery to 80,000 people will be provided by 45 substations. As shown by numerical simulation of the Oradea geothermal reservoir, injection of heat-depleted geothermal fluid in the tapped aquifer will prevent reservoir pressure decline, with no significant thermal breakthrough over 30 years of production (Antics, 1996).

The capital investment cost for the full proposed geothermal development program has been estimated at US$ 9 million. A discounted cash-flow analysis of the project shows attractive indices: net present value of about US$ 1.7 million, discounted pay-back time of 6.6 years, and internal rate of return of 20%, at a discounted unit price of US$ 12.5/Mwht (the price of natural gas is US$ 8.5/Mwht; thermal energy is US$ 17.2/Mwht).
In accordance with the energy strategy envisaged by the City of Oradea Municipality, the economic assessment was carried out for this type of a company (named Company of Oradea for Gas and Geothermal Exploitation [COGGE]), which will include the Municipality of Oradea, the District Heating Section of APATERM, a major investor or consortium, and minor private share holders.

The Municipality of Oradea will be awarded, by the National Agency for Mineral Resources, according to the provisions of the new Mining Law, the License of Exploitation of the Oradea geothermal reservoir. The Municipality will then concede the exploitation to the COGGE, together with the natural gas distribution activity.

The Oradea geothermal reservoir contains two specific aquifers that are hydraulically connected: the Triassic aquifer Oradea and the Cretaceous aquifer Felix Spa. The Oradea aquifer is located in Triassic limestone and dolomite, at depths of 2200-3400 m, with an approximate areal extent of 113 km2 . This aquifer is exploited by 12 wells, with a total artesian flow rate of 140 l/s and wellhead temperatures of 70-105ºC. The water is of calcium-sulfate-bicarbonate type, with no scaling or corrosion potential. There are no dissolved gases, and the TDS is lower than 0.9-1.2 g/l. The reservoir is bounded by faults. There are also internal faults in the reservoir, dividing it into four blocks which do not cause discontinuities in the circulation of the water in the reservoir. The main circulation is from the north-eastern part of the reservoir, along preferential pathways represented by the fault system at the boundary.

The water is about 20,000 years old, the recharge area being in the Western Carpathian Mountains 20-30 km east of Oradea.

Site/Project Name	***Otopeni***
Location	44.33 Latitude, 26.07 Longitude; 15 km north of Bucharest
Status	Direct use -- developed
Temperature (ºC) from	58
Temperature (ºC) to	72
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	5
Potential (MWt)	2.7
Chronology	1990 - Exploration pumped well drilled to 3204 m; flow rate of 20 kg/s, wellhead pressure of -60 m, and heat output of 2.7 MWt.
Notes	The geothermal resource is used for the district heating of 1900 buildings. The geothermal water has temperatures of 58-72ºC and a mineralization of 1.5-2.2g/l, with a high content of H_2S (over 25 ppm). Reinjection is compulsory. The production is carried out using down hole pumps, because the water level is 80 m below the surface. The total flow rate is 25-30 l/s. At present, only 3 wells are in production (5 MWt). Two wells are used for reinjection. The system, which also has heavy fuel-fired peak load boilers, is being modernized to increase its energy efficiency (Rosca and Bendea, 1999). The development is hampered by technical and, mostly, by financial difficulties.

Romania

The Otopeni geothermal reservoir is only partially delimited (about 300 km²). The 12 wells that were drilled show a huge aquifer located in fissured limestone and dolomites, situated at a depth of 1900-2600 m, which belongs to the Moesic Platform (Cohut and Bendea, 1999).

Site/Project Name	***Periam***
Location	46.02 Latitude, 20.53 Longitude
Status	Direct use -- developed
Temperature (ºC) from	58
Temperature (ºC) to	80
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.9
Potential (MWt)	0.8
Chronology	1990 - Exploration artesian well drilled to 1400 m; flow rate of 10 kg/s, heat output of 0.8 MWt.
Notes	The geothermal resource is used for heating and balneology. Flow rate is 10 kg/s; inlet and outlet temperatures are 70ºC and 25ºC, respectively; annual energy utilization is 35.6 TJ; capacity factor is 60% (Cohut and Bendea, 2000).

Site/Project Name	***Ploiesti***
Location	In south-central Romania; north of Bucharest
Status	Preliminary identification/repo

Romania

Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Sacuieni***
Location	47.21 Latitude, 22.06 Longitude
Status	Direct use -- developed
Temperature (ºC) from	80
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	5.1
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for heating, balneology, greenhouses, aquaculture, and industrial process heat.

Flow rate is 22 kg/s; inlet and outlet temperatures are 80ºC and 25ºC, respectively; annual energy utilization is 87.1 TJ; capacity factor is 55% (Cohut and Bendea, 2000).

Site/Project Name	***Salonta***
Location	46.48 Latitude, 21.41 Longitude
Status	Feasibility study
Temperature (ºC) from	95
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Sannicolau***
Location	46.04 Latitude, 20.35 Longitude; in southwestern Romania; in Timis county
Status	Direct use -- developed
Temperature (ºC) from	78
Temperature (ºC) to	88
Installed capacity (MWe)	0

Romania

Potential (MWe)	0
Installed capacity (MWt)	10
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for industrial process heat, heating, balneology, and greenhouses. The geothermal resource is used to provide hot water and heat 750 flats. The system uses three wells with a total flow rate of 27 l/s and a wellhead temperature of 80ºC, and has two heat stations with peak load boilers (Rosca and Bendea, 1999). Flow rate is 50 kg/s; inlet and outlet temperatures are 78ºC and 30ºC, respectively; annual energy utilization is 221.6 TJ; capacity factor is 70% (Cohut and Bendea, 2000).

Site/Project Name	***Santandrei***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	150
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1994 - Exploration well drilled to 3500 m; flow rate of 50 kg/s, wellhead pressure of 5 bar.

Romania

Notes	New wells are being drilled in the Santandrei area where it is hoped that the temperatures will be sufficiently high to supply fluid to ORC generators for electricity (KAPA Systems, 1999).

Site/Project Name	***Saravale***
Location	46.04 Latitude, 20.45 Longitude
Status	Direct use -- developed
Temperature (ºC) from	75
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.7
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for heating and balneology. Flow rate is 8 kg/s; inlet and outlet temperatures are 75ºC and 25ºC, respectively; annual energy utilization is 33.0 TJ; capacity factor is 62% (Cohut and Bendea, 2000).

Site/Project Name	***Satu Mare***
Location	47.48 Latitude, 22.53 Longitude; in northwestern Romania
Status	Direct use -- developed

Romania

Temperature (ºC) from	65
Temperature (ºC) to	88
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.8
Potential (MWt)	
Chronology	1990 - Exploration pumped well drilled to 1460 m; flow rate of 3.6 kg/s, wellhead pressure of -75 m, and heat output of 0.4 MWt.
Notes	The geothermal resource is used for heating and balneology. Flow rate is 12 kg/s; inlet and outlet temperatures are 65ºC and 30ºC, respectively; annual energy utilization is 32.3 TJ; capacity factor is 58% (Cohut and Bendea, 2000).

Site/Project Name	***Semlac***
Location	46.07 Latitude, 20.56 Longitude
Status	Direct use -- developed
Temperature (ºC) from	55
Temperature (ºC) to	65
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0.4

Romania

Chronology	1991 - Exploration pumped well drilled to 1462 m; flow rate of 6 kg/s, wellhead pressure of -34 m, and heat output of 0.4 MWt.
Notes	

Site/Project Name	***Snagov***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	83
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	3.6
Chronology	1991 - Exploration pumped well drilled to 3273 m; flow rate of 20 kg/s, wellhead pressure of -36 m, and heat output of 3.6 MWt. 1994 - Exploration pumped well drilled to 3200 m.
Notes	

Site/Project Name	***Sofronea***
Location	46.17 Latitude, 21.19 Longitude
Status	Direct use -- developed

Romania

Temperature (ºC) from	42
Temperature (ºC) to	70
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.4
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for heating and balneology. Flow rate is 6 kg/s; inlet and outlet temperatures are 42ºC and 25ºC, respectively; annual energy utilization is 6.7 TJ; capacity factor is 50% (Cohut and Bendea, 2000).

Site/Project Name	***Tasnad***
Location	47.29 Latitude, 22.35 Longitude
Status	Direct use -- developed
Temperature (ºC) from	70
Temperature (ºC) to	88
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.9
Potential (MWt)	0
Chronology	

Romania

Notes	The geothermal resource is used for heating, balneology, and greenhouses. Flow rate is 10 kg/s; inlet and outlet temperatures are 70ºC and 25ºC, respectively; annual energy utilization is 41.5 TJ; capacity factor is 70% (Cohut and Bendea, 2000).

Site/Project Name	***Teremia***
Location	45.56 Latitude, 20.31 Longitude
Status	Direct use -- developed
Temperature (ºC) from	85
Temperature (ºC) to	90
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	3.5
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for industrial process heat, heating, and balneology. Flow rate is 15 kg/s; inlet and outlet temperatures are 85ºC and 30ºC, respectively; annual energy utilization is 43.5 TJ; capacity factor is 40% (Cohut and Bendea, 2000).

Site/Project Name	***Timisoara***
Location	45.45 Latitude, 21.14 Longitude; in southwestern Romania
Status	Direct use -- developed

Romania

Temperature (ºC) from	31
Temperature (ºC) to	60
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.3
Potential (MWt)	0
Chronology	1902 - Well drilled; encountered temperature of 31ºC.
Notes	The geothermal resource is used for heating and balneology. Flow rate is 15 kg/s; inlet and outlet temperatures are 45ºC and 25ºC, respectively; annual energy utilization is 26.4 TJ; capacity factor is 67% (Cohut and Bendea, 2000).

Site/Project Name	***Tomnatic***
Location	45.59 Latitude, 20.40 Longitude; in the Western Plain
Status	Direct use -- developed
Temperature (ºC) from	80
Temperature (ºC) to	84
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	9.4
Potential (MWt)	0
Chronology	

Romania

Notes	The geothermal resource is used for to heat 7.5 hectares of greenhouses, and for balneology. Flow rate is 45 kg/s; inlet and outlet temperatures are 80ºC and 30ºC, respectively; annual energy utilization is 145.1 TJ; capacity factor is 49% (Cohut and Bendea, 2000). The requirement of the greenhouses is for 41 kg/s water at a minimum of 70ºC in the colder part of the winter (October-February) and 29 kg/s in the other period (March- April) (Antics, 2000). Broadly the reservoir may be considered as horizontal, with infinite extent and without recharge. Eight wells were drilled in the area. From the geophysical logging and the continuous coring programs carried out during drilling, three productive intervals were defined.

Site/Project Name	***Tusnad-Bai***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	15
Temperature (ºC) to	300
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0.5
Chronology	Late 1970s - A deep drilling program targeted two thermal anomalies. The drilling showed that the shallow high thermal gradients (250-400ºC/km) sharply decrease with depth to moderately above-normal values (40-70ºC/km) to virtually an isothermal profile (Radulescu et al., 1981; Mitrofan, 2000). The existence of a deep geothermal reservoir was suggested in the first place by several warm

springs (15-23ºC).

The highest down hole temperature, 78ºC, was recorded at the bottom (1140 m) of well 320. During tests, the well discharged 4 kg/s of sodium bicarbonate, 12.5-13 g/l TDS, nearly neutral (pH values of 7.2-7.5), 63ºC water. The Na-K geothermometer indicated that, compared to the springs, the water discharged by the well originated in a reservoir separate from and cooler than (at ~ 180ºC) the reservoir which conceptually feeds the thermal springs (Mitrofan, 2000).

Well 322 (750 m) had poorer results in terms of both its maximum bottomhole temperature (54ºC), and output (46ºC wellhead temperature, recorded during a 2 kg/s swabbing discharge test).

The combined Na-K-Mg geothermometer method was applied to water samples collected (1961, Peter, 1984, Craciun and Bandrabur, 1993) from the thermal springs lineament and from the deep wells 320 and 322. Only the samples from well 320 fall within the "partial equilibrium" domain, and hence are fully appropriate for the analysis provided by the Na-K-Mg geothermometer.

The data points plot on two distinct Na-K isotherms: approximately 180ºC for the well data points, and 300ºC for the springs. This suggests that, the springs on one hand, and the deep wells on the other, are supplied by two distinct deep reservoirs, of highly contrasting temperatures.

The apparent cooling indicated by the K-Mg temperatures between well 320 and well 322 suggests that the 180ºC deep reservoir which supplies the aquifer tapped by those two wells is situated somewhere southward of well 320. Currently there seems to be no further way to locate it more precisely.

Notes

The most significant hydrothermal activity in the area consists of a lineament of springs that discharge about 5 kg/s (aggregate flow rate) of sodium chloride thermal water which is CO_2 rich, relatively low in TDS (1.5-4.5 g/l), and has a maximum temperature of 23ºC. The Na-K geothermometer indicates that the spring waters could have originated from a hot (~300ºC) reservoir of thermal fluid.

Romania

The analysis indicates that an intermediate or high temperature deep reservoir could occur a few kilometers away (probably to the north) from the surface manifestations at Tusnad-Bai. The thermal springs at Tusnad-Bai appear to be a lateral outflow of this deep reservoir, while currently existing well bores discharge water from a much cooler reservoir, completely separate.

Further information on the geothermal potential of the deep reservoir inferred to exist north of Tusnad-Bai may be readily obtained by detailed discharge, temperature and chemistry surveys of the Olt river in the considered area. On the other hand, a more precise delineation of the reservoir requires detailed exploration studies (electrical resistivity, shallow thermal gradient holes, deep drilling).

Carbon dating (14 C) ages ranging between 10,700 and >42,650 years BP have been reported by various investigators for organic matter (charcoal fragments included in a pumice flow deposit; paleosoil underlying the pumice deposit) from Ciomadul volcano, next to Tusnad-Bai. This is the most recent volcanic eruption in Romania documented to date, and it implies the existence of a still active magma chamber, with which a high temperature (>225ºC) geothermal system might be associated (Mitrofan, 2000).

The possible existence of a geothermal system associated with the young volcanic activity in the South Harghita mountains was considered in the light of recent advances in chemical geothermometry and assessment principles of geothermal systems.

The total heat naturally discharged by the currently known springs in Tusnad-Bai amounts to about 0.5 MWt.

Site/Project Name: ***Varias***

Location: 46.01 Latitude, 20.58 Longitude

Status: Direct use -- developed

Romania

Temperature (ºC) from	65
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Videle***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	40
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1990 - Exploration pumped well drilled to 2231 m; flow rate of 8 kg/s, wellhead pressure of -96 m.
Notes	

Romania

Site/Project Name	***Zerind***
Location	46.38 Latitude, 21.32 Longitude
Status	Preliminary identification/repo
Temperature (ºC) from	98
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Slovakia

Site/Project Name	***Banovce n/Bebravou***
Location	48.43 Latitude, 18.16 Longitude
Status	Direct use -- developed
Temperature (ºC) from	40
Temperature (ºC) to	55
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	1.78
Chronology	1984 to 1985 - Two wells drilled to depths of 1512-2025 m. Discharge ranges from 2.0-17.0 l/s; TDS from 0.7-6.0 g/l (Remlik and Fendek, 1994).
Notes	The geothermal resource is used for bathing and swimming. The resource has a flow rate of 23 l/s, an inlet temperature of 46ºC, and supplies 51.4 TJ/yr (Fendek and Franko, 2000). Aquifer contains Triassic dolomites. Heat power estimated at 0.33-1.78 MWt (Remlik and Fendek, 1994).

Site/Project Name	***Besenova***
Location	In the Liptov Basin; in Zilina county
Status	Direct use -- developed

Slovakia

Temperature (ºC) from	30
Temperature (ºC) to	62
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1997 - Space heating system for a hotel and greenhouses began operating.
Notes	The geothermal resource is used for recreational swimming in a thermal spa and greenhouses. The resource has a flow rate of 27 l/s, an inlet temperature of 62ºC, and supplies 52.2 TJ/yr (Fendek and Franko, 2000). Besenova is the most important geothermal installation in Zilina county. Temperatures vary from 45ºC in Besenova horst to 30ºC on the periphery. Geothermal waters flowing up from a depth of more than 1500 m heat the Besenova horst (Fendek and Franko, 2000).

Site/Project Name	***Bojnice***
Location	In the Horna Nitra Basin in the central part of the country
Status	Direct use -- developed
Temperature (ºC) from	45
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0

Slovakia

Installed capacity (MWt) 0

Potential (MWt) 19.6

Chronology

Notes

The geothermal resource is used for balneology. The Bojnice spa was declared a natural therapeutic spa as established by the Health Ministry.

More than 15 wells from 30-1178 m have been drilled close to the natural thermal spring outflows in the area of the Bojnice spa. Only five are presently operating. A model demonstrated that the exploitation rate from Bojnice must not exceed 27 l/s if the groundwater is to be stabilized at present levels.

The Bojnice high block structure and the deep reservoir of Horna Nitra are independent structures which are separated by the Malomagursky fault.

The Horna Nitra Basin is located between the Ziar Mountains in the northeast, the Vtacnik Mountains in the southeast, and the Stazovske vrchy Mountains in the west and northwest. Its heat potential is estimated to be 19.6 MWt (Fendekova and Fendek, 2000).

Site/Project Name ***Calovo***

Location

Status Direct use -- developed

Temperature (ºC) from 57

Temperature (ºC) to 75

Installed capacity (MWe) 0

Potential (MWe) 0

Slovakia

Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for bathing and swimming and greenhouses. The resource has a flow rate of 10-16 l/s, an inlet temperature of 57-73ºC, and supplies 87.6 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Central depression***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	23
Temperature (ºC) to	92
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	6.8
Chronology	1971 to 1990 - 34 wells drilled to depths of 276-2487 m. Discharge ranges from 0.3-25.0 l/s; TDS from 0.5-8.3 g/l (Remlik and Fendek, 1994).
Notes	Aquifer contains Neogene sands, sandstones, and conglomerates. Heat power estimated at 0.13-6.80 MWt (Remlik and Fendek, 1994).

Site/Project Name	***Chalmova***

Slovakia

Location	In the Horna Nitra Basin in the central part of the country
Status	Direct use -- developed
Temperature (ºC) from	39
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology. The Horna Nitra Basin's heat potential is estimated to be 19.6 MWt (Fendekova and Fendek, 2000). The Horna Nitra Basin is located between the Ziar Mountains in the northeast, the Vtacnik Mountains in the southeast, and the Stazovske vrchy Mountains in the west and northwest.

Site/Project Name	***Cilizska Radvan***
Location	
Status	Direct use -- developed
Temperature (ºC) from	64
Temperature (ºC) to	82
Installed capacity (MWe)	0

Slovakia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for greenhouses. The resource has a flow rate of 6-17 l/s, an inlet temperature of 64-82ºC, and supplies 90.2 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Diakovce***
Location	
Status	Direct use -- developed
Temperature (ºC) from	63
Temperature (ºC) to	68
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for bathing and swimming and heating. The resource has a flow rate of 12 l/s, an inlet temperature of 63ºC, and supplies 43.5 TJ/yr (Fendek and Franko, 2000).

Slovakia

Site/Project Name	***Dubnik depression***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	52
Temperature (ºC) to	75
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	2.4
Chronology	1989 to 1990 - Two wells drilled to depths of 745-1905 m. Discharge ranges from 1.5-15.0 l/s; TDS from 10.0-30.0 g/l (Remlik and Fendek, 1994).
Notes	Aquifer contains Badenian sandstones and conglomerates. Heat power estimated at 0.25-2.4 MWt (Remlik and Fendek, 1994).

Site/Project Name	***Dunajska Streda***
Location	
Status	Direct use -- developed
Temperature (ºC) from	55
Temperature (ºC) to	91
Installed capacity (MWe)	0
Potential (MWe)	0

Slovakia

Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for bathing and swimming, heating, and greenhouses. The resource has a flow rate of 15-23 l/s, an inlet temperature of 55-91ºC, and supplies 123.4 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Dunajsky Klatov***
Location	
Status	Direct use -- developed
Temperature (ºC) from	74
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for greenhouses. The resource has a flow rate of 10 l/s, an inlet temperature of 74ºC, and supplies 54.1 TJ/yr (Fendek and Franko, 2000).

Slovakia

Site/Project Name	***Durkov***
Location	In eastern Slovakia; in the southeastern part of the Kosice Basin; 15 km east of the town of Kosice
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	115
Temperature (ºC) to	150
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	45
Chronology	1968 to 1972 - Oil and gas exploration wells were drilled. Although oil and gas were not found, DST tests showed geothermal water inflow from Mesozoic dolomites. 1998 to 1999 - Three exploratory wells (GTD-1, 2, and 3) proved the existence of a geothermal reservoir on the top of Mesozoic dolomites just below Neogene Carpathian conglomerates (Kovac et al., 1998; Vranovska et al., 2000). The heat output of each well is about 15 MWt; reservoir has a total heat potential of at least 100 MWt.
Notes	The Durkov geothermal center of the TEKO Kosice district heating system has a wellhead temperature of 125°C, a flow rate of 60–65 kg/s, and maximum reinjection temperature of 55-60°C. One well can deliver heat output of 16 MWt (Benovsky et al., 2000).

Site/Project Name	***Gabcikovo***
Location	
Status	Direct use -- developed

Slovakia

Temperature (ºC) from	52
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for bathing and swimming. The resource has a flow rate of 10 l/s, an inlet temperature of 52ºC, and supplies 8.7 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Galanta***
Location	In the Central Depression of the Danube Basin in the Gabcikovo geothermal structure; in Trnava county; in the southern part of the country; west pf Podhajska; 50 km east of Bratislava; 48.11 Latitude, 17.47 Longitude
Status	Direct use -- developed
Temperature (ºC) from	40
Temperature (ºC) to	91
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	8

Slovakia

Potential (MWt) 32.1

Chronology

1982 to 1983 - The Dionyz Stur Institute of Geology Bratislava drilled research borehole FGG-2 Galanta to provide heat to the Town Hospital Complex. The well confirmed that the resource could be used to generate power; temperature at the wellhead is 80ºC with free outflow of 27.3 l/s. (Fendek and Franko, 2000).

1984 - The Bratislava branch of the IGHP, s.p. Zilina company drilled FGG-3 Galanta; encountered a wellhead temperature of 77ºC with a flow rate of 25.0 l/s.

1996 - First geothermal heating plant to provide heat and hot water was put online with a capacity of 8 MWt. System run by Galantaterm, Ltd. Financial support was received from the Slovak gas industry, the Town of Galanta, Slovgeoterm, NEFCO Helsinki, and Hitaveita Reykjavik. Wells are used alternatively.

Notes

The geothermal resource is used for swimming pools, greenhouses, district heating, and hot water.

The geothermal energy provides heating to 1,236 flats in the "Sever" quarter, a complex of Regional Hospital buildings, and a home for retired people, supplying about 80% of the annual energy demand. Total installed capacity is 8 MWt. The payback period is seven years. Slovgeoterm Company implemented and developed the geothermal energy utilization in Galanta.

The resource has a flow rate of 10-50 l/s, an inlet temperature of 61-80ºC, and supplies 139.8 TJ/yr (Fendek and Franko, 2000). The chemical composition of the water is Na-HCO3 to Na-HCO3–Cl type with TDS 7 g/l (Benovsky et al., 2000).

Total geothermal heat power is estimated at 32.1 MWt (Fendek, 2000).

Site/Project Name ***Ganovce***

Location

Slovakia

Status	Well(s) or hole(s) drilled
Temperature (ºC) from	24
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1879 - First geothermal well in the Slovak Republic drilled to 183 m. The value of free outflow was 13.5 l/s of 24ºC water.
Notes	

Site/Project Name	***Handlova***
Location	In north central Slovakia; in the Stredoslovensky department
Status	Preliminary identification/repo
Temperature (ºC) from	22
Temperature (ºC) to	39
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	

Slovakia

Notes

Site/Project Name	***Hlohovec***
Location	In northwestern Slovakia; in the Zapadoslovensky department
Status	Preliminary identification/repo
Temperature (ºC) from	24
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Horna Nitra Basin***
Location	In the central part of the country
Status	Direct use -- developed
Temperature (ºC) from	45
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0

Slovakia

Installed capacity (MWt)	0
Potential (MWt)	19.6
Chronology	1962 - Well S1-NB drilled to 1688 m in Kos village. Well was later cemented. 1980 - Well S1-NB-II drilled to 1851 m.
Notes	The Horna Nitra Basin's heat potential is estimated to be 19.6 MWt (Fendekova and Fendek, 2000). Geothermal manifestations are located at Bojnice and Chalmova. The Horna Nitra Basin is located between the Ziar Mountains in the northeast, the Vtacnik Mountains in the southeast, and the Stazovske vrchy Mountains in the west and northwest. The Bojnice high block structure and the deep reservoir of Horna Nitra are independent structures which are separated by the Malomagursky fault.

Site/Project Name	***Horna Poton***
Location	
Status	Direct use -- developed
Temperature (ºC) from	66
Temperature (ºC) to	68
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Slovakia

Chronology	
Notes	The geothermal resource is used for greenhouses. The resource has a flow rate of 20 l/s, an inlet temperature of 68ºC, and supplies 67.5 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Komarno***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	20
Temperature (ºC) to	56
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	7.33
Chronology	1972 to 1990 - Six wells drilled to depths of 77-1761 m. Discharge ranges from 5.5-70.0 l/s; TDS from 0.7-90.0 g/l (Remlik and Fendek, 1994).
Notes	The geothermal resource is used for bathing and swimming. Triassic dolomite aquifer with limestones, Neogene sands, and conglomerates. Heat power estimated at 0.12-7.33 MWt (Remlik and Fendek, 1994). The resource has a flow rate of 5 l/s, an inlet temperature of 40ºC, and supplies 3.7 TJ/yr (Fendek and Franko, 2000).

Slovakia

Site/Project Name	***Komjatice depression***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	78
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	2.5
Chronology	1989 - One well drilled to 1700 m. Discharge of 12.0 l/s; TDS of 20.1 g/l (Remlik and Fendek, 1994).
Notes	Aquifer contains Pannonian sands and sandstones. Heat power estimated at 2.50 MWt (Remlik and Fendek, 1994).

Site/Project Name	***Kosice***
Location	In eastern Slovakia; in the Kosice Basin; 15 km west of Durkov; between the Ore Mountains on the west and the Slanske vrchy Mountains on the east
Status	Feasibility study
Temperature (ºC) from	115
Temperature (ºC) to	165
Installed capacity (MWe)	0
Potential (MWe)	0

Slovakia

Installed capacity (MWt)	0
Potential (MWt)	110

Chronology

1968 to 1972 - Three exploration oil wells were drilled (Durkov 1, 2, and 3).

1992 - Remsik and Fendek designed the first district heating project for 100-110 MWt to heat Kosice.

1995 to 2000 - Project received support from the Danish Government through the DANCEE program.

1997 - Feasibility study conducted by CFG Orleans of France, Virkir Reykjavik of Iceland and Slovgeoterm Bratislava of Slovakia. Geoterm-Kosice, Ltd. was established to implement the project. Projected payback period is five years.

Eight production and reinjection wells will be required. With six doublets exploited to their full capacity, the geothermal operation will ensure about 45% of the annual heat demand of TEKO, and with ten doublets 65%, based on the 1998 demand (Bjornsson and Tournaye, 1999). Seven doublets could cover about 50% of the annual energy demand. Heat exchange centers will be located in Bidovce, Durkov, Slanec, and Ruskov. TEKO Kosice, the district heating service, will be managed by Slovak Electricity.

1998 to 1999 - Three exploratory wells (GTD-1, 2, and 3) with wellhead temperatures of 124-129ºC were drilled in the Durkov geothermal structure, confirming the presence of a reservoir with heat potential of at least 100 MWt. The reservoir is located about 15 km east of Kosice at a depth of 2000-3000 m.

TEKO Kosice will deliver the heat by pipeline from heat center in Olsovany where the heat will come from well sites heat exchangers in Bidovce, Durkov, Slanec, and Ruskov. The geothermal heat will supply the dwellings of the town Kosice by already existed network from TEKO Kosice.

Slovakia

	1998 - First three wells of eight planned were drilled. June 2001 - Operation is scheduled to begin.
Notes	The geothermal resource will be used for district heating in the first stage of development. In the second stage, electrical energy production and waste heat utilization will be examined. Kosice, the second biggest town in Slovakia with an installed central heating network, will be the site of the largest geothermal heating project in Central Europe with a planned installed capacity of 100-110 MWt. The system will supply 60,000 flats in Kosice. An overall capacity of 700 MWt is under consideration (Fendek, 2001). The prospective part of the Kosice basin that has geothermal resources suitable for power generation covers an area of 200 km2 around the village of Durkov. The source of geothermal water is in Triassic dolomites, mainly in the upper part on contact with Neogene overlying rocks. The major inflow comes from fissure and karstic permeability zones at 2100–2600 m (Benovsky et al., 2000).

Site/Project Name	***Kovacova***
Location	
Status	Direct use -- developed
Temperature (ºC) from	40
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0

Slovakia

Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1899 - Second geothermal well in the Slovak Republic drilled to 473 m. Free outflow was 12.5 l/s at 40.5ºC. 1958 - Direct space heating system installed in spa.
Notes	The geothermal resource is used for balneology, space heating, and hot water.

Site/Project Name	***Kralova pri Senci***
Location	
Status	Direct use -- developed
Temperature (ºC) from	52
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for bathing and swimming and greenhouses. The resource has a flow rate of 13 l/s, an inlet temperature of 52ºC, and supplies 7.2 TJ/yr (Fendek and Franko, 2000).

Slovakia

Site/Project Name	***Levice***
Location	In western Slovakia; in the Zapadoslovensky department
Status	Direct use -- developed
Temperature (ºC) from	26
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	126
Chronology	1973 to 1986 - Two wells drilled to depths of 995-1740 m. Discharge ranges from 28.0-53.0 l/s; TDS from 19.2-19.6 g/l (Remlik and Fendek, 1994).
Notes	The geothermal resource is used for space heating, greenhouses, and balneology. The total energy potential of geothermal water of the Levice block is 126 MWt (Fendek and Franko, 2000).

Site/Project Name	***Lipovce***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0

Slovakia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Liptov basin***
Location	
Status	Feasibility study
Temperature (ºC) from	32
Temperature (ºC) to	62
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	34.3
Chronology	1976 to 1991 - Four wells drilled to depths of 1315-2486 m. Discharge ranges from 6.0-31.0 l/s; TDS from 0.5-4.8 g/l (Remlik and Fendek, 1994).
Notes	Triassic dolomite aquifer with limestones. Heat power estimated at 0.43-5.89 MWt (Remlik and Fendek, 1994). Natural thermal springs are located in Liptovska Stiavnica, Liptovske Sliace, Liptovsky Jan, and Lucky Villages with temperatures of 20-32ºC.

Slovakia

The thermal energy potential of Liptov basin is estimated at 34.3 MWt (Fendek and Franko, 2000).

Site/Project Name	***Nove Zamky***
Location	
Status	Direct use -- developed
Temperature (ºC) from	58
Temperature (ºC) to	59
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for bathing and swimming. The resource has a flow rate of 4 l/s, an inlet temperature of 59ºC, and supplies 16.9 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Oravice***
Location	
Status	Direct use -- developed
Temperature (ºC) from	56
Temperature (ºC) to	0

Slovakia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for bathing and swimming. The resource has a flow rate of 110 l/s, an inlet temperature of 56ºC, and supplies 34.3 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Partizanske***
Location	In north central Slovakia; in the Stredoslovensky department
Status	Preliminary identification/repo
Temperature (ºC) from	40
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Slovakia

Site/Project Name	***Pezinok***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Piestany***
Location	84 km northwest of Bratislava
Status	Direct use -- developed
Temperature (ºC) from	69
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Slovakia

Potential (MWt)	0
Chronology	1113 - Piestany settlement first mentioned in documents. 1412 - Piestany spa first mentioned in documents. 1546 - The first authentic record of the unique effects of the Piestany spa was found in a letter. 1778 - First wooden building housing tub baths was built. 1813 to 1821 - Accommodations were built; spa town was improved. 1912 - Luxurious spa hotel Thermia Palace and the balneotherapeutic center, Irma, were completed. 1940 - Spa became the property of the State. 1958 - Direct space heating system installed in spa.
Notes	The geothermal resource is used for balneology, space heating, and hot water. Piestany is the leading spa in Slovakia for the treatment of locomotoric system diseases, including rheumatism. The spa treats approximately 40,000 patients per year (Lund, 1992). The resource originates at 2000 m; surface springs flow at a rate of over 3 million liters/day. The spring water is cooled from 69ºC to 35-40ºC for use in pools and baths.

Site/Project Name	***Podhajska***
Location	In Nitra county; about 90 km east of Bratislava in the northeastern part of the Danube Basin; in southern Slovakia; east of Galanta
Status	Direct use -- developed

Slovakia

Temperature (ºC) from	80
Temperature (ºC) to	82
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	12
Potential (MWt)	126.14

Chronology

1973 - Well Po-1 was drilled encountering a Na-Cl type of geothermal water with 19 g/l TDS. The well was exploited for greenhouses and recreational purposes.

Due to environmental rules and a pressure drop, reinjection well GRP-1 (1470 m) was drilled, 2000 m northeast of Po-1. The heat output of the well is 12 MWt (Benovsky et al., 2000).

1994 - Reinjection plant completed. Two wells were completed becoming the first geothermal doublet in the country. Po-1 and reinjection well GRP-1 are 1900 and 1470 m deep, with discharge rates of 53.0 and 28.0 l/s, and temperatures of 82 and 69.5ºC respectively (Fendek and Franko, 2000).

Notes

The geothermal resource is used to heat greenhouses, houses, and swimming pools.

The project in Podhajska is focused on greenhouses heating in an area of 2 ha via heat exchangers. The geothermal water passes through heat exchangers and further through poly-propylene pipe. The exchange station contains three plate exchangers with titanic plates with a total capacity of 10.5 MWt. The exchangers were delivered from France firm VICARB. Scale and corrosion inhibitors are used (Vana and Franko, 1997; Benovsky et al., 2000). Slovgeoterm Company implemented and developed the project.

The resource has a flow rate of 45 l/s, an inlet temperature of 80ºC, and supplies 102.9 TJ/yr (Fendek and Franko, 2000).

Slovakia

Podhajska is located in the Levice block, one of the 26 hydrogeothermal structures in Slovakia. The probable total thermal energy potential of the geothermal waters in Levice block is 126.14 MWt (Benovsky et al., 2000).

Site/Project Name	***Poprad***
Location	In the Vysoke Tatry area
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used to heat 500 flats and an indoor swimming pool.

Site/Project Name	***Rajecke Teplice***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0

Slovakia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Rudno***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Ruzomberok***
Location	In north central Slovakia; in the Stredoslovensky department
Status	Preliminary identification/repo

Slovakia

Temperature (ºC) from	22
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Sala***
Location	
Status	Direct use -- developed
Temperature (ºC) from	42
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for bathing and swimming.

The resource has a flow rate of 3 l/s, an inlet temperature of 42ºC, and supplies 5.5 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Sklene Teplice***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1958 - Direct space heating system installed in spa.
Notes	The geothermal resource is used for balneology and space heating.

Site/Project Name	***Skorusina***
Location	
Status	Feasibility study
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0

Slovakia

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Sliac***
Location	In north central Slovakia; in the Stredoslovensky department
Status	Direct use -- developed
Temperature (ºC) from	33
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Sturovo***
Location	In southwestern Slovakia; in the Zapadoslovensky department; near the border with Hungary
Status	Direct use -- developed

Slovakia

Temperature (ºC) from	23
Temperature (ºC) to	40
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for bathing and swimming. The resource has a flow rate of 70 l/s, an inlet temperature of 40ºC, and supplies 23.7 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Svaty Jur***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	

Slovakia

Notes	The geothermal resource is used for balneology.

Site/Project Name	***Topolniky***
Location	
Status	Direct use -- developed
Temperature (ºC) from	74
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for bathing and swimming, greenhouses, and heating. The resource has a flow rate of 23 l/s, an inlet temperature of 74ºC, and supplies 61.7 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Topolovec***
Location	
Status	Direct use -- developed
Temperature (ºC) from	61
Temperature (ºC) to	0

Slovakia

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for greenhouses. The resource has a flow rate of 10 l/s, an inlet temperature of 61ºC, and supplies 34.3 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Trencianske Teplice***
Location	
Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology.

Slovakia

Site/Project Name	***Turcianske Terplice***
Location	In north central Slovakia; in the Stredoslovensky department
Status	Direct use -- developed
Temperature (ºC) from	22
Temperature (ºC) to	45
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	1958 - Direct space heating system installed in spa.
Notes	The geothermal resource is used for balneology, space heating, and hot water.

Site/Project Name	***Tvrdosovce***
Location	
Status	Direct use -- developed
Temperature (ºC) from	70
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Slovakia

Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for bathing and swimming and greenhouses. The resource has a flow rate of 20 l/s, an inlet temperature of 70ºC, and supplies 71.2 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Upper Nitra basin***
Location	
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	66
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	4.85
Chronology	1979 to 1980 - One well drilled to 1851 m. Discharge of 26.0 l/s; TDS of 0.93 g/l (Remlik and Fendek, 1994).
Notes	Aquifer contains Triassic limestones and dolomites. Heat power estimated at 4.85 MWt (Remlik and Fendek, 1994).

Site/Project Name	***Vienna basin***
Location	

Slovakia

Status	Well(s) or hole(s) drilled
Temperature (ºC) from	73
Temperature (ºC) to	78
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	6.59
Chronology	1982 to 1984 - Two wells drilled to depths of 1242-2570 m. Discharge ranges from 12.0-25.0 l/s; TDS from 6.8-10.9 g/l (Remlik and Fendek, 1994).
Notes	Triassic dolomite aquifer with limestones. Heat power estimated at 2.91-6.59 MWt (Remlik and Fendek, 1994).

Site/Project Name	***Vlcany***
Location	
Status	Direct use -- developed
Temperature (ºC) from	58
Temperature (ºC) to	68
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Slovakia

Chronology

Notes The geothermal resource is used for greenhouses.

The resource has a flow rate of 10 l/s, an inlet temperature of 58ºC, and supplies 28.5 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Vrbov***
Location	In the Vysoke Tatry area
Status	Direct use -- developed
Temperature (ºC) from	55
Temperature (ºC) to	59
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for recreation and fish farming. The resource has a flow rate of 28-33 l/s, an inlet temperature of 55-59ºC, and supplies 109.4 TJ/yr (Fendek and Franko, 2000).

Site/Project Name	***Vyhne***
Location	

Slovakia

Status	Direct use -- developed
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for balneology.

Site/Project Name	***Ziar nad Hronom***
Location	In central Slovakia in the Ziar depression
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	90
Temperature (ºC) to	95
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	30
Chronology	1995 and 1996 - Geophysical and geological surveys were done.

1995 to 2000 - Project received support from the Danish Government through the DANCEE program.

1997 - Houe & Olsen, a Danish company, conducted a feasibility study to evaluate using the geothermal resource to supply 70% of the heating needs of the town (pop. 27,000) and the ZSNP Aluminum Plant, replacing coal and natural gas. According to the study, four wells (two production and two reinjection) with a total pumped yield of 150 l/s and wellhead temperatures of 90-95ºC would be required. Total investment estimated at US$ 20 million; payback period of 6-7 years (Franko and Majersky, 2000).

1999 - Drilling of first of four geothermal wells, RGZ-1, began. Designed depth is 2500 m. In the 1700-1800 m interval, large mud losses occurred and it was decided to test for geothermal water (Franko and Majersky, 2000).

From the preliminary results of the seismic measurements it is clear that the part where the first well was located is tectonically destroyed and occurrence of volcanic intrusive is evident. Subsequent wells will be located in the central part of Ziar basin.

Notes

Air pollution in this region is among the worst in the country making it necessary to use renewable sources of energy in the new heating system. The application of geothermal energy will have a great influence in decreasing the emission decreasing of contaminants as CO2, CO, SO2, Nox, and dust.

The Ziar basin belongs to the territory of the Central Slovakian Neovolcanics (Neogene volcanic) which occupy an extensive area in the center of the Inner West Carpathians. Geothermal activity in the area is suggested by a multitude of natural thermal springs (Franko and Majersky, 2000).

Site/Project Name	***Zvolen***
Location	In north central Slovakia; in the Stredoslovensky department
Status	Preliminary identification/repo

Slovakia

Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Ukraine

Site/Project Name	***Beregovo***
Location	In Zakarpattya oblast
Status	Feasibility study
Temperature (ºC) from	70
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	15

Chronology

1997 - Danish company, Houe and Olsen, assessed the resource and project through the DANCEE program.

About 15 wells have been drilled for various purposes. In all the boreholes, well logging, well tests, and geochemical sampling of thermal water have been carried out.

Analysis of well test data was carried out using graphical methods (Semi-log and Horner methods) and the VARFLOW computer software. The results of this analysis indicates that the average transmissivity of the Beregovsky reservoir is about 0.5×10-5 m3 Pa-s. A lumped parameter model using the LUMPFIT computer program was used to simulate the Beregovsky geothermal area and predict the reservoir response to three constant production rate cases over the next 10 years (Barylo, 2000).

Notes

The geothermal resource will be used to heat three five-story buildings, replacing a gas-fired boiler. Total project cost is US$ 30 million.

It is estimated that the energy potential of the Beregovsky geothermal area is 1.23 ×10*17 J and the possible direct use potential (e.g. space heating) produced for a 25-year period is estimated to be about 15 MWt.

The estimated resources are 85,000 m3/day. The aquifer depth is 900-1500 m (Dolinsky et al., 2001).

Site/Project Name	***Glibivska***
Location	In the Republic of Crimea
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	127
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Oktjabrska 7-H drilled to 1036 m

Site/Project Name	***Gorobtsivska***
Location	In Poltava oblast
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	146
Temperature (ºC) to	0

Ukraine

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Gorobtsivska 12 drilled to 4470 m

Site/Project Name	***Ilyinka***
Location	In the Republic of Crimea; near the Black Sea coast; north of Evpatoria; in the Novoselovskoe drilling site
Status	Direct use -- developed
Temperature (ºC) from	57
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for residential space heating.

Site/Project Name	***Irshava***

Ukraine

Location	In Zakarpattya oblast
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	0
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Some of the drillings in the region of the town of Irshava also demonstrated significant free-flowing hot water. At that site, an anticline crypto-diapir fold is to be found under the Neogene mantel. Most promising are the waters in Cretaceous sedimentary environments. Such waters and environments have been discovered by the drillings at Irshava-2, located in the area of the Danilovo-Nevitskovo abyssal fracture. The water-bearing rock is of fissured type, probably due to the fracture zone. Mineralization is about 189 g/l (Stoyanov and Taylor, 1996).

Site/Project Name	***Izjum***
Location	In Kharkiv oblast
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	198
Temperature (ºC) to	0
Installed capacity (MWe)	0

Ukraine

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Well drilled to 3900 m

Site/Project Name	***Kerchensky***
Location	In the Republic of Crimea
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	200
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Well drilled to 4000 m encountered temperatures over 200ºC.

Site/Project Name	***Kotelnikovo***
Location	In the Republic of Crimea
Status	Direct use -- developed

Ukraine

Temperature (ºC) from	65
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	2
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for residential space heating.

Site/Project Name	***Krasnogvardeisk***
Location	In the Republic of Crimea
Status	Feasibility study
Temperature (ºC) from	91
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	60
Chronology	
Notes	The geothermal resource will be used for district heating for five eight-story buildings, replacing a gas-fired boiler. Total installed capacity will be 60 MWt at a total project cost of US$ 25 million.

The estimated resources are 140,000 m3/day. The aquifer depth is 2230-2600 m (Dolinsky et al., 2001).

The Danish company, House and Olsen, has assessed the resource and project.

Site/Project Name	***Medvedevka***
Location	In the Republic of Crimea
Status	Direct use -- developed
Temperature (ºC) from	67
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1.5
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for space heating. Thermal waters contain dissolved methane which is recovered and used to fuel a diesel engine.

Site/Project Name	***Mostyska***
Location	In Lviv oblast
Status	Well(s) or hole(s) drilled

Ukraine

Temperature (ºC) from	128
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Well drilled to 1950 m

Site/Project Name	***Nizinnoye***
Location	In the Republic of Crimea
Status	Direct use -- developed
Temperature (ºC) from	47
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0.5
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for hot water supply.

Ukraine

Site/Project Name	***Novo-Alekseyevka***
Location	In the Republic of Crimea
Status	Direct use -- developed
Temperature (ºC) from	54
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	3
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for space heating on a dairy farm.

Site/Project Name	***Novomechebylivska***
Location	In Kharkiv oblast
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	152
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Ukraine

Potential (MWt)	0
Chronology	
Notes	Novomechebylivska 2-P drilled to 3800 m

Site/Project Name	***Oktjabrska***
Location	In the Republic of Crimea
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	158
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Oktjabrska 5 drilled to 2407 m

Site/Project Name	***Pyatihatki***
Location	In the Republic of Crimea
Status	Direct use -- developed
Temperature (ºC) from	51
Temperature (ºC) to	0

Ukraine

Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for hot water supply.

Site/Project Name	***Rovnoye***
Location	In the Republic of Crimea
Status	Direct use -- developed
Temperature (ºC) from	62
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	3
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for space heating.

Site/Project Name	***Severo-Sivashkoe***
Location	Northeast of Djankoi in the Republic of Crimea; near the Sea of Azov

Ukraine

Status	Well(s) or hole(s) drilled
Temperature (ºC) from	52
Temperature (ºC) to	74
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	

Site/Project Name	***Shevchenkivska***
Location	In Kharkiv oblast
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	168
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	

Notes	Shevchenkivska 8 drilled to 3100 m

Site/Project Name	***Sizovka***
Location	In the Republic of Crimea; near the Black Sea coast; north of Evpatoria; in the Novoselovskoe drilling site
Status	Direct use -- developed
Temperature (ºC) from	61
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for residential space heating.

Site/Project Name	***Spivakovsky***
Location	In Kharkiv oblast
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	174
Temperature (ºC) to	0
Installed capacity (MWe)	0

Ukraine

Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Well drilled to 3900 m

Site/Project Name	***Tarkhancutsky***
Location	In the Republic of Crimea
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	200
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Well drilled to 4000 m encountered temperatures over 200ºC.

Site/Project Name	***Tereblia***
Location	In Zakarpattya oblast
Status	Well(s) or hole(s) drilled

Ukraine

Temperature (ºC) from	95
Temperature (ºC) to	105
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0

Chronology

1980s - As a result of studies carried out, the site was determined to be of the second highest priority for commercial utilization.

Well Tereblia-6, drilled in the central part of the syncline, reached pressurized water-bearing horizon in the interval between 2009 and 2360 meters. The well is a gushing type, with flow-rates between 500 and 900 cubic meters per day. The pressure at the well head was measured at 1.2 Atm. The pressure at 1767 meters was 217 Atm. Water mineralization is in the range of 138 g/l. Water temperature measured at 2350 meters was 105ºC, and at the wellhead was 95ºC (Tereblia-6).

Notes

The hydro-geothermal complex at the Tereblia site is of significant interest. The formation is located in the central part of the Solotvinskaia depression. The maximum thickness of the water bearing tuffs is 700 meters. The dip angle of the thrust fault planes of the Cretaceous blocks of the base is between 5-20 degrees. The water bearing suites are enveloped between these practically water-impermeable blocks and talabor rock which is also water impermeable. This creates very favorable conditions for the accumulation of geothermal waters.

The size of the Tereblia water-bearing complex is 15x5 km. Assuming the thickness of the water-bearing rock is 300 m and the porosity of the rock is 10%, the accumulated reserves are 3 km3 . With a temperature of over 100ºC, the accumulated thermal energy is 1.5x10*18 J (A. A. Andrusenka et al.; Stoyanov and Taylor, 1996).

Ukraine

Site/Project Name	***Trudovoye***
Location	In the Republic of Crimea; near the Black Sea coast; north of Evpatoria; in the Novoselovskoe drilling site
Status	Direct use -- developed
Temperature (ºC) from	53
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for a greenhouse and hot water supply.

Site/Project Name	***Uzhgorod***
Location	In Zakarpattya oblast
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	108
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0

Ukraine

Potential (MWt) 0

Chronology

Notes

The Uzhgorod site is characterized, as is the territory of the entire depression, by a block structure of pre-Neogene folding base. Multi-directional tectonic movements of the blocks have resulted in significant variations in the depth of the base. The highest part is the Uzhgorod transversal uplift. The roof of the base is located at a depth of less than 1000 meters. Uneven, but sometimes up to hundreds of meters thick, the sedimentary mantle of lower Miocene is a significant structural element of the hydro-geothermal environment of this site.

The most productive area proved to be the sandstone water bearing horizon of the adjacent Russko-Komarovskii uplift. The name of the drill-site is Uzhgorod-2T. The mineralization of the water is 16-30 g/l. The formation pressure at 1700 m is 167.9 Atm. and at 1300 m, 134.64 Atm. A maximum water temperature of 108ºC was measured at a depth of 1940 m.

The discovered hydro-geothermal resources have been determined to have no commercial value and are currently in conservation. The geological and hydro-geological investigation carried out at the site is however considered insufficient to a large extent (Stoyanov and Taylor, 1996).

Site/Project Name ***Yantarne***

Location In the Republic of Crimea

Status Direct use -- developed

Temperature (ºC) from 85

Temperature (ºC) to 0

Installed capacity (MWe) 0

Potential (MWe) 0

Ukraine

Installed capacity (MWt)	5
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for residential space heating. The Danish company, House and Olsen, has assessed the resource and project.

Site/Project Name	***Zaluzska***
Location	In Zakarpattiya oblast
Status	Well(s) or hole(s) drilled
Temperature (ºC) from	210
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	0
Potential (MWt)	0
Chronology	
Notes	Zaluska 3 drilled to 4050 m

Site/Project Name	***Zernovoye***
Location	In the Republic of Crimea
Status	Direct use -- developed

Ukraine

Temperature (ºC) from	50
Temperature (ºC) to	0
Installed capacity (MWe)	0
Potential (MWe)	0
Installed capacity (MWt)	1
Potential (MWt)	0
Chronology	
Notes	The geothermal resource is used for hot water supply.